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THE CHINESE LOESS PUZZLE.

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THE appearance of the first volume of Baron F. von Richthofen's magnificent work on China[1] furnishes us with a suitable opportunity to put before the readers of the NATURALIST a brief account of one of the most curiously puzzling geological phenomena which has ever been brought to the notice of the scientific world, — the distribution and mode of occurrence of the so-called loess deposits of Northern China. The term *loess* is one in popular use in the valley of the Rhine for a peculiar loamy material[2] which occurs over a considerable area between Constance and the Belgian lowlands, having in places a thickness of as much as one or two hundred feet, and which is generally admitted to have been a lacustrine deposit, formed when the Rhine was swollen by the melting of the great Alpine glaciers, which then extended much below their present level and covered a far greater area than they now do. Important as this formation is in that region, it sinks into insignificance when compared with what is presented by the Chinese deposits of similar character.

The Chinese loess, like that of the Rhine, is an earthy substance of a brownish-yellow color, so tender and little coherent that it can be easily rubbed to a powder between the fingers. It is chiefly made up of argillaceous materials, with a small proportion of carbonate of lime; and it has also mixed with it more or less fine sand, the grains of which are quite angular. This sand, however, is small in quantity as compared with the argillaceous

[1] China, Ergebnisse eigener Reisen und darauf gegründeter Studien, Erster Band, Einleitender Theil. Berlin, 1877.

[2] Loess is very nearly the equivalent of the English word loam. Perhaps the best way to define it would be to say that loam when developed enough to become a formation of geological importance, and not a mere surface deposit, is loess.

portion. The most striking facts with regard to this material in China are its wide-spread distribution and its enormous thickness, — facts which, taken in connection with its composition and structure, render its origin one of the most perplexing of geological problems.

First, as to its distribution. According to Richthofen, this formation is spread over a large part of the region drained by the Hwang-Ho or Yellow River, — a name derived from the color of the material which this great stream is continually carrying in suspension towards the Yellow Sea, in which name we again recognize the coloration given by the particles of the loess, which itself is called by the Chinese *hwang-tu* or yellow earth. For nearly a thousand miles from the borders of the great alluvial plain of Pechele, through the provinces of Shansi, Shensi, and Kansu, everywhere to the north of the Wei, which runs along the northern base of the range of the Tsing-ling-shan, the loess may be followed up to the very divide which separates the basin of the Hwang-Ho from the region destitute of drainage into the sea. Towards the north, it reaches almost to the edge of the Mongolian plateau. Furthermore, it may be observed in the province of Honan, along the south side of the most easterly outliers of the Kwenlun, filling a large portion of the middle part of the basin of the Han, covering large areas in Shantung, and reaching southwards in isolated patches as far as the Yangtse. The area over which the loess spreads itself almost continuously is as large as the whole of Germany ; while it is found in more or less detached portions over an additional area nearly half as large as that empire.

From the known topographical character of the loess-covered region, it will be recognized at once that the formation in question occurs at very varying altitudes, or that it is distributed without regard to the elevation of the surface on which it rests. From near the level of the sea up to six thousand feet and more above it, this characteristic material lies, covering valley and mountain slope, absent only on the crests of some of the higher dividing ridges. This extraordinary range of vertical position has not been given to the loess by changes of level of the land since it was deposited, for Richthofen declares that it clearly results from his researches that the relative position of the higher and lower portions of the region in question has not been changed since the deposition of the loess; although he believes that, as a whole, its eastern border has been depressed in altitude, the

coast-line formerly extending farther out into the sea than it now does. So much for the horizontal and vertical distribution of the loess, and now some of its structural conditions may be noticed.

Two peculiarities strike the eye of the observer at once on examining the material in question: in the first place, the entire absence of any indications of stratification; and, second, the tendency which it everywhere exhibits to cleave or crack in vertical planes. These peculiarities, however, would not make such a strong impression on the mind of the geologist if it were not for the enormous thickness of the deposit, which is usually several hundred and in places reaches fifteen hundred or even two thousand feet. To see such a mass of material, not of igneous origin, destitute of any indication of stratification, is something entirely out of the ordinary experience of the geological observer. It would seem impossible that such a deposit could have been laid down except from water, and, if so, where are the lines of deposition, which never fail to make themselves visible in aqueous sediments? The problem, as will be seen, begins to present itself as a puzzle. But it may be asked, Is not this a deposit from water, in which, owing to some peculiar conditions, the lines of stratification have become obliterated? The answer to this is readily given in the negative, when on investigation it is found that this deposit, hundreds of feet in thickness, contains imbedded within its mass no fossil remains of marine or fresh-water origin, but only land shells — mostly those of snails — and occasional bones of land animals. It is evident, then, that this so-called loess is not similar in origin to that of the Rhine Valley, as indeed might easily have been inferred from its position at all elevations over plain and mountain side; but that it is a subaerial deposit.

Apart from theoretical considerations of origin, which make this loess formation so interesting, there are other circumstances resulting from its mode of occurrence, which bear on the daily life of the people inhabiting these loess-covered districts, and so connect themselves with their agriculture, their roads, and their means of military defense as to be abundantly striking, even to the observer who cares nothing for geological problems, and to whom the absence of lines of stratification would not appear as a noticeable fact. The peculiar type of scenery which these great areas, covered by such a thickness of soft, easily eroded material, present could not fail to impress itself on the mind of the most careless observer. And we find that the main features of the landscape in the loess districts are closely connected in their ori-

gin with the tendency which this material possesses — as already noticed — to divide into masses separated by vertical planes; a peculiarity which is not properly cleavage, neither is it exactly what geologists call jointing, but something near akin to it. As a result of this tendency, we find that the rivers which run through the loess-covered districts are bordered by absolutely vertical walls of this material, sometimes hundreds of feet in height. Given the elements of great thickness of the deposits, extreme facility of erosion due to the softness of the mass, and the tendency to vertical cleavage, and it can easily be imagined that the resulting forms left from the action of erosive agencies must be extremely complex and peculiar. Indeed, as described by Richthofen, the loess-covered region is certainly one of the most curious portions of the earth's surface. It somewhat resembles the Colorado plateau, in being deeply and intricately furrowed by drainage channels of great depth, and proportionately very narrow. In the Colorado region, however, the walls of the cañons, as these gorges are there called, are never vertical, though usually quite steep, and the material on which the water exercises its erosive power has a greater variety of texture and color than that offered by the loess, which is remarkably homogeneous from top to bottom. The difficulty of traversing such a region, or even of engineering roads through it, can readily be imagined. It is not so much of a task to keep on one main divide between two systems of gorges; but to go across the country in any fixed direction is almost an impossibility. Tunnels and spiral stairways in the mass of the loess must often be resorted to. In short, the configuration of the surface is, as Richthofen remarks, most fantastic and curious. "Wide chasms are surrounded by castles, towers, peaks, and needles, all made up of yellow earth, between which gorges and chasms radiate labyrinthically upwards into the walls of solid ground around. High up on a rock of earth, steeper than any rock of stone, stands the temple of the village, or a small fortress which affords the villagers a safe retreat in times of danger. The only access to such a place is by a spiral stairway dug out within the mass of the bluff itself. In this yellow defile there are innumerable nooks and recesses, often enlivened by thousands of people, who dwell in caves dug out in the loess.[1]"

Millions of human beings live in habitations excavated in this

[1] Richthofen, Letter on the Provinces of Chili, Shansi, Shensi, and Sz'-chwan. Shanghai, 1872.

material. These dwellings vary in character from mere holes in the ground to commodious mansions. The largest houses for the entertainment of travelers are sometimes excavated to a distance of two hundred feet into the ground, with corresponding breadth and height, so that numerous guests, with their vehicles and animals, can be housed with comfort, small side apartments being cut out adjacent to the large one for sleeping quarters. The walls of these extraordinary dwellings are lined with cement made from the calcareous nodules which the loess often contains; this arrangement tends to cleanliness and durability, and dwellings thus protected sometimes last for hundreds of years, being warm in winter and cool in summer. It must be a most curious experience to travel over the surface of a highly cultivated loess district, and to see no signs of any inhabitants, until one comes to some point where the vertical wall of yellow earth is exposed to view, in and out of the holes in which the people are seen swarming like bees around a bee-hive. To the traveler looking down from an adjacent elevation on to one of the loess basins, the surface seems uniform in character with a gently descending slope, easily accessible and green with vegetation; from the bottom of one of the gorges, on the other hand, only the bare, vertical loess walls are visible, while the whole mass is found to be intersected with a labyrinth of deep and, from the general level, inaccessible gorges.

Such are some of the more striking peculiarities of the loess formation. But, besides its tendency to vertical cleavage, it exhibits a more or less complete arrangement in thick layers, and this has been taken by some observers for a real stratification, which, however, as Richthofen considers that he has clearly established, it is not. This pseudo-stratification depends for its existence on horizontal lines of calcareous concretions, like what we call clay-stones, the *Loessmännchen* of the dwellers on the Rhine, and which the Chinese call by a name which means "stone ginger," from the resemblance of these concretionary forms to the roots of the ginger plant. That these loessmännchen have been formed in the loess by infiltration along the lines of cleavage and resultant chemical action on calcareous matter occurring in large quantity along certain planes, and that they are not the product of anything like deposition from water, is clearly shown by their vertical position in the material in which they are found; had they been swept into their places by a current of water, they must have been laid upon their flat surfaces. These imperfectly

formed concretionary layers exercise an important influence in determining a terrace-like form of the sides of the gorges worn down in the loess, which often rise in a succession of steps, having this peculiarity: that there is little or no talus or sloping pile of débris along the line where the vertical and horizontal surfaces meet. The natural tendency to this condition of things is assisted in its development by the labors of those who cultivate the soil, and for whose advantage it is to gain as much flat surface as possible.

The first person to notice and describe these remarkable deposits was Professor Pumpelly, who, in 1864, journeyed over a portion of the loess-covered districts lying along the southern border of Mongolia. His observation, however, did not, by any means, extend over so wide an area as those of Richthofen, and his theory of the origin of the loess appears to be insufficiently supported by the facts which a much larger and more exhaustive investigation of the country brought to light; still, it must be admitted that there are difficulties which no theory seems able fully to overcome. Professor Pumpelly considered the loess, which he describes under the name of "terrace deposit," as a lacustrine formation, each of the basins in which this material occurs having been once the bed of a lake, a series of large bodies of fresh water being assumed as formerly extending along the course of the Hwang-Ho, which did not then occupy its present position, but ran in a pretty direct line, connecting the different basins, from Ning-hia-fu to Peking. This theory, therefore, demands that there should have been a considerable diminution in the quantity of water formerly covering the region in question. It seems the most plausible one at first sight, however, and other observers — as for instance Kingsmill — have not hesitated to adopt and defend it.

The difficulties which this theory presents seem, as developed by Richthofen, almost, if not quite, insurmountable. The main arguments urged against Pumpelly's theory will be readily inferred from what has been stated in the preceding paragraphs. The absence of indications of stratification, and the constant presence in the material of land instead of fresh-water shells, and of bones of land animals, are facts which it seems impossible to set aside, since they result from prolonged observations made by a most skillful geologist. Besides, the loess indicates by its structure the growth on its surface during deposition of an abundant vegetation. The plants themselves — grasses, chiefly — are

no longer there; but the constant occurrence of innumerable delicate, elongated cavities, occupying a nearly vertical position, ramifying and inosculating at very acute angles, just as do the rootlets of plants, shows their former presence. It is to this peculiarity that the tendency to vertical cleavage, which is so conspicuously manifested in the loess, is largely due.

There is a greater difficulty still, if possible, in the way of the adoption of the lacustrine origin of these deposits. As Richthofen declares with the utmost confidence, based on a thorough examination of the region, the loess everywhere exhibits itself as a deposit which was not laid down until after the surface of the country where it occurs had assumed its present configuration. The orographic conditions are not such as, by any possibility, could allow of the formation of a connected series of lake-like expansions of the Hwang-Ho, as is demanded by Professor Pumpelly's theory.

Richthofen, therefore, unhesitatingly declares himself in favor of a subaerial origin of the loess; and he endeavors to account for the accumulation of this enormous mass of material in the following manner. In the first place, and as a necessity of the proposed theory, the district of the loess was once destitute of outward drainage, consisting, in fact, of a number of closed basins, such as are still found occurring in the adjacent region to the west in Central Asia. These closed basins were prairies, and the loess is "the collective residue of uncountable generations of herbaceous plants." It is the inorganic residuum which has accumulated during an immense lapse of time as the result of the decay of a vigorous prairie growth, ever renewing itself on the surface of the slowly accumulating deposit. But how is the increase of the deposit provided for by the theory? Unless there be some source supplying material from without, there can evidently be no gain in thickness, however many generations of plants succeed each other. The necessary addition of mineral matter Richthofen considers to have been brought into these basins by two agencies, the rain and the wind, and the latter especially plays an important part in this theory. Each basin being surrounded by a rim of rocks, constantly undergoing decomposition, the particles thus set free were either swept down the mountain sides towards the central area by rain, or blown thither by air currents, and once entangled among the vegetation could not be carried farther.

The facts being assumed to be as Richthofen states them, it

would appear that no other theory than this can be adopted for their explanation. A marine origin is rendered impossible by the absence of marine fossils, the constant presence of land shells and bones of land animals, as also by the absence of stratification and the very great differences of level at which the formation rests. The same arguments apply to the theory of a lacustrine origin, except that the one last mentioned would not present insuperable difficulties, or at least not any greater ones than those which the adoption of Richthofen's views implies. Either theory seems to need for its support changes of climate and a certain amount of alteration in the configuration of the surface. If the loess were deposited in closed basins, these are now opened to the sea and drained by the Hwang-Ho. The areas once separated from each other are at present connected; the deposits they inclosed are now being swept away to the sea. It is impossible to account for this changed condition of things without admitting a considerable increase in the amount of precipitation over the region in question, and it is not easy to see how a complete drainage system could have been established without the formation of a certain number of lakes, nor why these should all have disappeared so completely. According to the lacustrine theory, on the other hand, the precipitation is now less than it formerly was: the mighty lakes have shrunk and disappeared, the Hwang-Ho is but the remnant of what was once a much larger stream. What change of level in the area thus drained would be required to fit this theory it seems difficult to make out. The appearance, in a future volume of Richthofen's great work, of the details of the cartography and geology of the region in question will, no doubt, be of much assistance in enabling one to form a clearer opinion of these matters. The interesting chapter in the volume already published, entitled Formation and Remodeling (Bildung und Umbildung) of the Salt Steppes of Central Asia, in which subjects closely connected with the question of the mode of formation of the loess are discussed at very considerable length, cannot at present be entered upon, for want of space. Its consideration may be taken up at a future time, when it will be found that it has important bearings on certain points closely related to our own surface geology, and which have not yet received anything like the attention which they deserve at the hands of our geological observers. It is sufficient, for the present, to have given the readers of the NATURALIST an idea of one among the many interesting topics treated in Richthofen's work. It should

be added, however, that the contents of the only volume as yet published refer chiefly to the historical development of geographical discovery in China and Central Asia, forming by far the most copious and thoroughly digested summary of facts ever as yet presented relating to this interesting but difficult subject.

THE COLORS OF ANIMALS AND PLANTS.[1]

BY ALFRED RUSSEL WALLACE.

I. THE COLORS OF ANIMALS.

Theory of Sexual Colors. — In Mr. Darwin's celebrated work, The Descent of Man and Selection in Relation to Sex, he has treated of sexual color in combination with other sexual characters, and has arrived at the conclusion that all, or almost all, the colors of the higher animals (including among these insects and all vertebrates) are due to voluntary sexual selection; and that diversity of color in the sexes is due, primarily, to the transmission of color-variations either to one sex only, or to both sexes, the difference depending on some unknown law, and not being due to natural selection.

I have long held this portion of Mr. Darwin's theory to be erroneous, and have argued that the primary cause of sexual diversity of color was the need of protection, repressing in the female those bright colors which are nominally produced in both sexes by general laws; and I have attempted to explain many of the more difficult cases on this principle (A Theory of Birds' Nests, in Contributions, etc., page 231). As I have since given much thought to this subject, and have arrived at some views which appear to me to be of considerable importance, it will be well to sketch briefly the theory I now hold, and afterward show its application to some of the detailed cases adduced in Mr Darwin's work.

The very frequent superiority of the male bird or insect in brightness or intensity of color, even when the general tints and coloration are the same, now seems to me to be due to the greater vigor and activity and the higher vitality of the male. The colors of an animal usually fade during disease or weakness, while robust health and vigor add to their intensity. This intensity of coloration is most manifest in the male during the breeding-season, when the vitality is at a maximum. It is also very manifest

[1] From Macmillan's Magazine. Concluded from page 662.

in those cases in which the male is smaller than the female, as in the hawks and in most butterflies and moths. The same phenomena occur, though in a less marked degree, among mammalia. Whenever there is a difference of color between the sexes the male is the darker or more strongly marked, and difference of intensity is most visible during the breeding season (Descent of Man, page 533). Numerous cases among domestic animals also prove that there is an inherent tendency in the male to special developments of dermal appendages and color, quite independently of sexual or any other form of selection. Thus, "the hump on the male zebu cattle of India, the tail of fat-tailed rams, the arched outline of the forehead in the males of several breeds of sheep, and the mane, the long hairs on the hind-legs, and the dewlap of the male of the Berbura goat," are all adduced by Mr. Darwin as instances of characters peculiar to the male, yet not derived from any parent ancestral form. Among domestic pigeons the character of the different breeds is often most strongly manifested in the male birds; the wattle of the carriers and the eye-wattles of the barbs are largest in the males, and male pouters distend their crops to a much greater extent than do the females, and the cock fantails often have a greater number of tail-feathers than the females. There are also some varieties of pigeons of which the males are striped or spotted with black, while the females are never so spotted (Animals and Plants under Domestication, i., 161); yet in the parent stock of these pigeons there are no differences between the sexes either of plumage or color, and artificial selection has not been applied to produce them.

The greater intensity of coloration in the male — which may be termed the normal sexual difference — would be further developed by the combats of the males for the possession of the females. The most vigorous and energetic usually being able to rear most offspring, intensity of color, if dependent on or correlated with vigor, would tend to increase. But as differences of color depend upon minute chemical or structural differences in the organism, increasing vigor acting unequally on different portions of the integument, and often producing at the same time abnormal developments of hair, horns, scales, feathers, etc., would almost necessarily lead also to variable distribution of color, and thus to the production of new tints and markings. These acquired colors would, as Mr. Darwin has shown, be transmitted to both sexes or to one only, according as they first ap-

peared at an early age, or in adults of one sex, and thus we may account for some of the most marked differences in this respect. With the exception of butterflies, the sexes are almost alike in the great majority of insects. The same is the case in mammals and reptiles, while the chief departure from the rule occurs in birds, though even here in very many cases the law of sexual likeness prevails. But in all cases where the increasing development of color became disadvantageous to the female, it would be checked by natural selection, and thus produce those numerous instances of protective coloring in the female only which occur in these two groups of animals.

There is also, I believe, a very important purpose and use of the varied colors of the higher animals, in the facility it affords for recognition by the sexes or by the young of the same species; and it is this use which probably fixes and determines the coloration in many cases. When differences of size and form are very slight, color affords the only means of recognition at a distance or while in motion, and such a distinctive character must therefore be of especial value to flying insects which are continually in motion, and encounter each other, as it were, by accident. This view offers us an explanation of the curious fact that among butterflies the females of closely-allied species in the same locality sometimes differ considerably, while the males are much alike; for as the males are the swiftest and the highest fliers and seek the females, it would evidently be advantageous for them to be able to recognize their true partners at some distance off. This peculiarity occurs with many species of *Papilio*, *Diadema*, *Adolias*, and *Colias*. In birds such marked differences of color are not required, owing to their higher organization and more perfect senses, which render recognition easy by means of a combination of very slight differential characters. This principle may, perhaps, however, account for some anomalies of coloration among the higher animals. Thus, Mr. Darwin, while admitting that the hare and the rabbit are colored protectively, remarks that the latter, while running to its burrow, is made conspicuous to the sportsman, and no doubt to all beasts of prey, by its upturned, white tail. But this very conspicuousness while running away may be useful as a signal and guide to the young, who are thus enabled to escape danger by following the older rabbits, directly and without hesitation, to the safety of the burrow; and this may be the more important from the semi-nocturnal habits of the animal. If this explanation is correct, and it certainly seems prob-

able, it may serve as a warning of how impossible it is, without exact knowledge of the habits of an animal and a full consideration of all the circumstances, to decide that any particular coloration cannot be protective or in any way useful. Mr. Darwin himself is not free from such assumptions. Thus, he says: "The zebra is conspicuously striped, and stripes cannot afford any protection on the open plains of South Africa." But the zebra is a very swift animal, and, when in herds, by no means void of means of defense. The stripes, therefore, *may* be of use by enabling stragglers to distinguish their fellows at a distance, and they *may* be even protective when the animal is at rest among herbage — the only time when it would need protective coloring. Until the habits of the zebra have been observed with special reference to this point, it is surely somewhat hasty to declare that the stripes "cannot afford any protection."

The wonderful display and endless variety of color in which butterflies and birds so far exceed all other animals seem primarily due to the excessive development and endless variations of the integumentary structures. No insects have such widely-expanded wings in proportion to their bodies as butterflies and moths; in none do the wings vary so much in size and form, and in none are they clothed with such a beautiful and highly-organized coating of scales. According to the general principles of the production of color already explained, these long-continued expansions of membranes and developments of surface-structures must have led to numerous color-changes, which have been sometimes checked, sometimes fixed and utilized, sometimes intensified, by natural selection, according to the needs of the animal. In birds, too, we have the wonderful clothing of plumage — the most highly-organized, the most varied, and the most expanded of all dermal appendages. The endless processes of growth and change during the development of feathers, and the enormous extent of this delicately-organized surface, must have been highly favorable to the production of varied color-effects, which, when not injurious, have been merely fixed for purposes of specific identification, but have often been modified or suppressed whenever different tints were needed for purposes of protection.

To voluntary sexual selection, that is, the actual choice by the females of the more brilliantly-colored males, I believe very little if any effect is directly due. It is undoubtedly proved that in birds the females do sometimes exert a choice; but the evidence of this fact collected by Mr. Darwin (Descent of Man, chapter

xiv.) does not prove that color determines that choice, while much of the strongest evidence is directly opposed to this view. All the facts appear to be consistent with the choice depending on a variety of male characteristics, with some of which color is often correlated. Thus it is the opinion of some of the best observers that vigor and liveliness are most attractive, and these are, no doubt, usually associated with intensity of color. Again, the display of the various ornamental appendages of the male during courtship may be attractive; but these appendages, with their bright colors or shaded patterns, are due probably to general laws of growth and to that superabundant vitality which we have seen to be a cause of color. But there are many considerations which seem to show that the possession of these ornamental appendages and bright colors in the male is not an important character functionally, and that it has not been produced by the action of voluntary sexual selection. Amid the copious mass of facts and opinions collected by Mr. Darwin as to the display of color and ornaments by the male birds, there is a total absence of any evidence that the females admire or even notice this display. The hen, the turkey, and the pea-fowl, go on feeding while the male is displaying his finery, and there is reason to believe that it is his persistency and energy rather than his beauty which wins the day. Again, evidence collected by Mr. Darwin himself proves that each bird finds a mate under any circumstances. He gives a number of cases of one of a pair of birds being shot, and the survivor being always found paired again almost immediately. This is sufficiently explained on the assumption that the destruction of birds by various causes is continually leaving widows and widowers in nearly equal proportions, and thus each one finds a fresh mate; and it leads to the conclusion that permanently-unpaired birds are very scarce; so that, speaking broadly, every bird finds a mate and breeds. But this would almost or quite neutralize any effect of sexual selection of color or ornament, since the less highly-colored birds would be at no disadvantage as regards leaving healthy offspring. If, however, heightened color is correlated with health and vigor, and these healthy and vigorous birds provide best for their young, and leave offspring which, being equally healthy and vigorous, can best provide for themselves, then natural selection becomes a preserver and intensifier of color. Another most important consideration is, that male butterflies rival or even excel the most gorgeous male birds in bright colors and elegant patterns; and

among these there is literally not one particle of evidence that the female is influenced by color, or even that she has any power of choice, while there is much direct evidence to the contrary (Descent of Man, page 318). The weakness of the evidence for sexual selection among these insects is so palpable that Mr. Darwin is obliged to supplement it by the singularly inconclusive argument that "unless the females prefer one male to another, the pairing must be left to mere chance, and this does not appear probable" (*loc. cit.*, page 317). But he has just said, "The males sometimes fight together in rivalry, and many may be seen pursuing or crowding round the same female;" while in the case of the silk-moths, "the females appear not to evince the least choice in regard to their partners." Surely, the plain inference from all this is, that males fight and struggle for the almost passive female, and that the most vigorous and energetic, the strongest-winged or the most persevering, wins her. How can there be chance in this? Natural selection would here act, as in birds, in perpetuating the strongest and most vigorous males, and as these would usually be the more highly-colored of their race, the same results would be produced as regards the intensification and variation of color in the one case as in the other.

Let us now see how these principles will apply to some of the cases adduced by Mr. Darwin in support of his theory of voluntary sexual selection.

In Descent of Man, second edition, pp. 307–316, we find an elaborate account of the various modes of coloring of butterflies and moths, proving that the colored parts are always more or less displayed, and that they have some evident relation to an observer. Mr. Darwin then says: "From the several foregoing facts it is impossible to admit that the brilliant colors of butterflies, and of some few moths, have commonly been acquired for the sake of protection. We have seen that their colors and elegant patterns are arranged and exhibited as if for display. Hence, I am led to believe that the females prefer or are most excited by the more brilliant males; for on any other supposition the males would, as far as we can see, be ornamented to no purpose" (*loc. cit.*, p. 316). I am not aware that any one has ever maintained that the brilliant colors of butterflies have "commonly been acquired for the sake of protection," yet Mr. Darwin has himself referred to cases in which the brilliant color is so placed as to serve for protection; as, for example, the eye-spots on the hind-wings of moths, which are pierced by birds, and

so save the vital parts of the insect, while the bright patch on the orange-tip butterflies, which Mr. Darwin denies are protective, may serve the same purpose. It is, in fact, somewhat remarkable how very generally the black spots, ocelli, or bright patches of color, are on the tips, margins, or disks of the wings; and, as the insects are necessarily visible while flying, and this is the time when they are most subject to attacks by insectivorous birds, the position of the more conspicuous parts at some distance from the body may be a real protection to them. Again, Mr. Darwin admits that the white color of the male ghost-moth may render it more easily seen by the female while flying about in the dusk, and if to this we add that it will be also more readily distinguished from allied species, we have a reason for diverse ornamentation in these insects quite sufficient to account for most of the facts, without believing in the selection of brilliant males by the females, for which there is not a particle of evidence. The facts given to show that butterflies and other insects can distinguish colors, and are attracted by colors similar to their own, are quite consistent with the view that color, which continually tends to appear, is utilized for purposes of identification and distinction, when not required to be modified or suppressed for purposes of protection. The cases of the females of some species of *Thecla*, *Callidryas*, *Colias*, and *Hipparchia*, which have more conspicuous markings than the male, may be due to several causes: to obtain greater distinction from other species, for protection from birds, as in the case of the yellow-under-wing moths, while sometimes—as in *Hipparchia*—the lower intensity of coloring in the female may lead to more contrasted markings. Mr. Darwin thinks that here the males have selected the more beautiful females, although one chief fact in support of his theory of voluntary sexual selection is, that throughout the whole animal kingdom the males are usually so ardent that they will accept any female, while the females are coy, and choose the handsomest males, whence it is believed the general brilliancy of males as compared with females has arisen.

Perhaps the most curious cases of sexual difference of color are those in which the female is very much more gayly colored than the male. This occurs most strikingly in some species of *Pieris* in South America, and of *Diadema* in the Malay islands, and in both cases the females resemble the uneatable Danaidæ and Heliconidæ, and thus gain a protection. In the case of *Pieris pyrrha*, *P. malenka*, and *P. lorena*, the males are plain white

and black, while the females are orange, yellow, and black, and so banded and spotted as exactly to resemble species of Heliconidæ. Mr. Darwin admits that these females have acquired these colors as a protection; but as there is no apparent cause for the strict limitation of the color to the female, he believes that it has been kept down in the male by its being *unattractive* to her. This appears to me to be a supposition opposed to the whole theory of sexual selection itself. For this theory is, that minute variations of color in the male are *attractive* to the female, have always been selected, and that thus the brilliant male colors have been produced. But in this case he thinks that the female butterfly had a constant aversion to every trace of color, even when we must suppose it was constantly recurring during the successive variations which resulted in such a marvelous change in herself. But if we consider the fact that the females frequent the forests where the Heliconidæ abound, while the males fly much in the open, and assemble in great numbers with other white and yellow butterflies on the banks of rivers, may it not be possible that the appearance of orange stripes or patches would be as injurious to the male as it is useful to the female, by making him a more easy mark for insectivorous birds among his white companions? This seems a more probable supposition than the altogether hypothetical choice of the female, sometimes exercised in favor of and sometimes against every new variety of color in her partner.

The full and interesting account given by Mr. Darwin of the colors and habits of male and female birds (Descent of Man, chapters xiii. and xiv.) proves that in most, if not in all, cases the male birds fully display their ornamental plumage before the females, and in rivalry with each other; but on the essential point of whether the female's choice is determined by minute differences in these ornaments or in their colors, there appears to be an entire absence of evidence. In the section on Preference for Particular Males by the Females, the facts quoted show indifference to color, except that some color similar to their own seems to be preferred. But in the case of the hen-canary, who chose a greenfinch in preference to either chaffinch or goldfinch, gay colors had evidently no preponderating attraction. There is some evidence adduced that female birds may, and probably do, choose their mates, but none whatever that the choice is determined by difference of color; and no less than three eminent breeders informed Mr. Darwin that they "did not believe that

the females prefer certain males on account of the beauty of their plumage." Again, Mr. Darwin himself says, "As a general rule, color appears to have little influence on the pairing of pigeons." The oft-quoted case of Sir R. Heron's peahens, which preferred an "old pied cock" to those normally colored, is a very unfortunate one, because pied birds are just those that are not favored in a state of nature, or the breeds of wild birds would become as varied and mottled as our domestic varieties. If such irregular fancies were not rare exceptions, the production of definite colors and patterns by the choice of the female birds, or in any other way, would be impossible.

We now come to such wonderful developments of plumage and color as are exhibited by the peacock and the Argus pheasant; and I may here mention that it was the latter bird, as fully discussed by Mr. Darwin, which first shook my belief in "sexual," or more properly "female," selection. The long series of gradations by which the beautifully-shaded ocelli on the secondary wing feathers of this bird have been produced are clearly traced out, the result being a set of markings so exquisitely shaded as to represent "balls lying loose within sockets," — purely artificial objects of which these birds could have no possible knowledge. That this result should have been attained through thousands and tens of thousands of female birds, all preferring those males whose markings varied slightly in this one direction, this uniformity of choice continuing through thousands and tens of thousands of generations, is to me absolutely incredible. And when, further, we remember that those which did not so vary would also, according to all the evidence, find mates and leave offspring, the actual result seems quite impossible of attainment by such means.

Without pretending to solve completely so difficult a problem, I would point out a circumstance which seems to afford a clew. It is that the most highly colored and most richly varied markings occur on those parts of the plumage which have undergone the greatest modification, or have acquired the most abnormal development. In the peacock the tail coverts are enormously developed, and the "eyes" are situated on the greatly dilated ends. In the birds-of-paradise, breast, or neck, or head, or tail feathers are greatly developed and highly colored. The hackles of the cock and the scaly breasts of humming-birds are similar developments; while in the Argus pheasant the secondary quills are so enormously lengthened and broadened as to have become almost useless for flight. Now, it is easily conceivable that, dur-

ing this process of development, inequalities in the distribution of color may have arisen in different parts of the same feather, and that spots and bands may thus have become broadened out into shaded spots or ocelli, in the way indicated by Mr. Darwin, much as the spots and rings on a soap-bubble increase with increasing tenuity. This is the more probable, as in domestic fowls varieties tend to become symmetrical, quite independently of sexual selection. (Descent of Man, page 424.)

If, now, we accept the evidence of Mr. Darwin's most trustworthy correspondents that the choice of the female, so far as she exerts any, falls upon the "most vigorous, defiant, and mettlesome male," and if we further believe, what is certainly the case, that these are, as a rule, the most brightly colored and adorned with the finest developments of plumage, we have a real and not a hypothetical cause at work. For these most healthy, vigorous, and beautiful males will have the choice of the finest and most healthy females, will have the most numerous and healthy families, and will be able best to protect and rear those families. Natural selection, and what may be termed male selection, will tend to give them the advantage in the struggle for existence, and thus the fullest plumage and the finest colors will be transmitted, and tend to advance in each succeeding generation.

There remains, however, what Mr. Darwin evidently considers his strongest argument, the display by the male of each species of its peculiar beauties of plumage and color. We have here, no doubt, a very remarkable and very interesting fact; but this, too, may be explained by general principles, quite independent of any choice or volition of the female bird. During pairing-time the male bird is in a state of great excitement, and full of exuberant energy. Even unornamented birds flutter their wings or spread them out, erect their tails or crests, and thus give vent to the nervous excitability with which they are overcharged. It is not improbable that crests and other erectile feathers may be primarily of use in frightening away enemies, since they are generally erected when angry or during combat. Those individuals who were most pugnacious and defiant, and who brought these erectile plumes most frequently and most powerfully into action, would tend to increase them by use, and to leave them further developed in some of their descendants. If, in the course of this development, color appeared, we have every reason to believe it would be most vivid in these most pugnacious and energetic individuals; and as these would always have the advantage in the

rivalry for mates (to which advantage the excess of color and plumage might sometimes conduce), there seems nothing to prevent a progressive development of these ornaments in *all dominant races*, that is, wherever there was such a surplus of vitality and such complete adaptation to conditions that the inconvenience or danger produced by them was so comparatively small as not to affect the superiority of the race over its nearest allies. If, then, those portions of the plumage which were originally erected and displayed became developed and colored, the actual display, under the influence of jealousy or sexual excitement, becomes intelligible. The males, in their rivalry with each other, would see what plumes were most effective, and each would endeavor to excel his enemy as far as voluntary exertion could effect it, just as they endeavor to rival each other in song, even sometimes to the point of causing their own destruction.

There is also a general argument against Mr. Darwin's views on this question, founded on the nature and potency of "natural" as opposed to "sexual" selection, which appears to me to be itself almost conclusive of the whole matter at issue. Natural selection, or the survival of the fittest, acts perpetually and on an enormous scale. Taking the offspring of each pair of birds as, on the average, only six annually, one third of these at most will be preserved, while the two thirds which are least fitted will die. At intervals of a few years, whenever unfavorable conditions occur, five sixths, nine tenths, or even a greater proportion of the whole yearly production are weeded out, leaving only the most perfect and best adapted to survive. Now, unless these survivors are on the whole the most ornamental, this rigid selective power must neutralize and destroy any influence that may be exerted by female selection. For the utmost that can be claimed for this is that a small fraction of the least ornamented do not obtain mates, while a few of the most ornamented may leave more than the average number of offspring. Unless, therefore, there is the strictest correlation between ornament and general perfection, the former can have no permanent advantage; and if there is (as I maintain) such a correlation, then the sexual selection of ornament, for which there is little or no evidence, becomes needless, because natural selection, which is an admitted *vera causa*, will itself produce all the results. In the case of butterflies the argument becomes even stronger, because the fertility is so much greater, and the weeding out of the unfit takes place, to a great extent, in the egg and larva state. Unless the eggs and larvæ

which escaped to produce the next generation were those which would produce the more highly colored butterflies, it is difficult to perceive how the slight preponderance of color sometimes selected by the females should not be wholly neutralized by the extremely rigid selection for other qualities to which the offspring in every stage are exposed. The only way in which we can account for the observed facts is by the supposition that color and ornament are strictly correlated with health, vigor, and general fitness to survive. We have shown that there is reason to believe that this is the case, and, if so, voluntary sexual selection becomes as unnecessary as it would certainly be ineffective.

There is one other very curious case of sexual coloring among birds: that, namely, in which the female is decidedly brighter or more strongly marked than the male, as in the fighting quails (*Turnix*), painted snipe (*Rhynchæa*), two species of phalarope (*Phalaropus*), and the common cassowary (*Casuarius galeatus*). In all these cases, it is known that the males take charge of and incubate the eggs, while the females are almost always larger and more pugnacious. In my Theory of Birds' Nests [1] I imputed this difference of color to the greater need for protection by the male bird while incubating, to which Mr. Darwin has objected that the difference is not sufficient, and is not always so distributed as to be most effective for this purpose; and he believes that it is due to reversed sexual selection, that is, to the female taking the usual *rôle* of the male, and being chosen for her brighter tints. We have already seen reason for rejecting this latter theory in every case, and I also admit that my theory of protection is, in this case, only partially, if at all, applicable. But the general theory of intensity of color being due to general vital energy is quite applicable; and the fact that the superiority of the female in this respect is quite exceptional, and is therefore probably not of very ancient date in any one case, will account for the difference of color thus produced being always comparatively slight.

Theory of Typical Colors. — The remaining kinds of animal colors — those which can neither be classed as protective, warning, nor sexual — are for the most part readily explained on the general principles of the development of color which we have now laid down. It is a most suggestive fact that, in cases where color is required only as a warning, as among the uneatable caterpillars, we find, not one or two glaring tints only, but every kind of color disposed in elegant patterns, and exhibiting almost

[1] Natural Selection, page 251.

as much variety and beauty as among insects and birds. Yet here, not only is sexual selection out of the question, but the need for recognition and identification by others of the same species seems equally unnecessary. We can then only impute this variety to the normal production of color in organic forms, when fully exposed to light and air and undergoing great and rapid developmental modification. Among more perfect animals, where the need for recognition has been added, we find intensity and variety of color at its highest pitch among the South American butterflies of the families Heliconidæ and Danaidæ, as well as among the Nymphalidæ and Erycinidæ, many of which obtain the necessary protection in other ways. Among birds, also, wherever the habits are such that no special protection is needed for the females, and where the species frequent the depths of tropical forests, and are thus naturally protected from the swoop of birds of prey, we find almost equally intense coloration, as in the trogons, barbets, and gapers.

Of the mode of action of the general principles of color development among animals, we have an excellent example in the humming-birds. Of all birds these are at once the smallest, the most active, and the fullest of vital energy. When poised in the air, their wings are invisible, owing to the rapidity of their motion, and when startled they dart away with the rapidity of a flash of light. Such active creatures would not be an easy prey to any rapacious bird; and if one at length was captured, the morsel obtained would hardly repay the labor. We may be sure, therefore, that they are practically unmolested. The immense variety they exhibit in structure, plumage, and color indicates a high antiquity for the race, while their general abundance in individuals shows that they are a dominant group, well adapted to all the conditions of their existence. Here we find everything necessary for the development of color and accessory plumes. The surplus vital energy shown in their combats and excessive activity has expended itself in ever-increasing developments of plumage and greater and greater intensity of color, regulated only by the need for specific identification, which would be especially required in such small and mobile creatures. Thus may be explained those remarkable differences of color between closely-allied species, one having a crest like the topaz, while in another it resembles the sapphire. The more vivid colors and more developed plumage of the males, I am now inclined to think, may be wholly due to their greater vital energy and to

those general laws which lead to such superior developments even in domestic breeds; but in some cases the need of protection by the female while incubating, to which I formerly imputed the whole phenomenon, may have suppressed a portion of the ornament which she would otherwise have attained.

Another real though as yet inexplicable cause of diversity of color is to be found in the influence of locality. It is observed that species of totally distinct groups are colored alike in one district, while in another district the allied species all undergo the same change of color. Cases of this kind have been adduced by Mr. Bates, by Mr. Darwin, and by myself, and I have collected all the more curious and important examples in my Address to the Biological Section of the British Association at Glasgow in 1876. The most probable cause for these simultaneous variations would seem to be the presence of peculiar elements or chemical compounds in the soil, the water, or the atmosphere, or of special organic substances in the vegetation; and a wide field is thus offered for chemical investigation in connection with this interesting subject. Yet, however we may explain it, the fact remains of the same vivid colors in definite patterns being produced in quite unrelated groups, which only agree, so far as we yet know, in inhabiting the same locality.

Let us now sum up the conclusion at which we have arrived as to the various modes in which color is produced or modified in the animal kingdom.

The various causes of color in the animal world are molecular and chemical change of the substance of their integuments, or the action on it of heat, light, or moisture. It is also produced by interference of light in superposed transparent lamellæ, or by excessively fine surface striæ. These elementary conditions for the production of color are found everywhere in the surface structures of animals, so that its presence must be looked upon as normal, its absence as exceptional.

Colors are fixed or modified in animals by natural selection for various purposes: obscure or imitative colors for concealment; gaudy colors as a warning; and special markings either for easy recognition by strayed individuals, females, or young, or to direct attack from a vital part, as in the large, brilliantly-marked wings of some butterflies and moths.

Colors are produced or intensified by processes of development, — either where the integument or its appendages undergo great extension or modification, or where there is a surplus of

vital energy, as in male animals generally, and more especially at the breeding-season.

Colors are also more or less influenced by a variety of causes, such as the nature of the food, the photographic action of light, and also by some unknown local action probably dependent on chemical peculiarities in the soil or vegetation.

These various causes have acted and reacted in a variety of ways, and have been modified by conditions dependent on age or on sex, on competition with new forms or on geographical or climatic changes. In so complex a subject, for which experiment and systematic inquiry have done so little, we cannot expect to explain every individual case, or solve every difficulty; but it is believed that all the great features of animal coloration and many of the details become explicable on the principles we have endeavored to lay down.

It will perhaps be considered presumptuous to put forth this sketch of the subject of color in animals as a substitute for one of Mr. Darwin's most highly elaborated theories, — that of voluntary or perceptive sexual selection, — yet I venture to think that it is more in accordance with the whole of the facts, and with the theory of natural selection itself; and I would ask such of my readers as may be sufficiently interested in the subject to read again chapters xi. to xvi. of the Descent of Man, and consider the whole theory from the point of view here laid down.

The explanation of almost all the ornaments and colors of birds and insects as having been produced by the perceptions and choice of the females has, I believe, staggered many evolutionists, but has been provisionally accepted, because it was the only theory that even attempted to explain the facts. It may perhaps be a relief to some of them, as it has been to myself, to find that the phenomena can be shown to depend on the general laws of development and on the action of "natural selection," which theory will, I venture to think, be relieved from an abnormal excrescence, and gain additional vitality by the adoption of my view of the subject.

Although we have arrived at the conclusion that tropical light and heat can in no sense be considered the cause of color, there remains to be explained the undoubted fact that all the more intense and gorgeous tints are manifested by the animal life of the tropics, while in some groups, such as butterflies and birds, there is a marked preponderance of highly colored species. This is probably due to a variety of causes, some of which we can indi-

cate, while others remain to be discovered. The luxuriant vegetation of the tropics throughout the entire year affords so much concealment that color may there be safely developed to a much greater extent than in climates where the trees are bare in winter, during which season the struggle for existence is most severe, and even the slightest disadvantage may prove fatal. Equally important, probably, has been the permanence of favorable conditions in the tropics, allowing certain groups to continue dominant for long periods, and thus to carry out in one unbroken line whatever development of plumage or color may once have acquired an ascendency. Changes of climatal conditions, and preëminently the Glacial epoch, probably led to the extinction of a host of highly developed and finely colored insects and birds in temperate zones, just as we know that it led to the extinction of the larger and more powerful mammalia which formerly characterized the temperate zone in both hemispheres. This view is supported by the fact that it is among those groups only which are now exclusively tropical that all the more extraordinary developments of ornament and color are found. The local causes of color will also have acted best in regions where the climatal conditions remained constant, and where migration was unnecessary; while whatever direct effect may be produced by light or heat will necessarily have acted more powerfully within the tropics. And, lastly, all these causes have been in action over an actually greater area in tropical than in temperate zones, while estimated potentially, in proportion to its life-sustaining power, the lands which enjoy a practically tropical climate (extending as they do considerably beyond the geographical tropics) are very much larger then the temperate regions of the earth. Combining the effects of all these various causes we are quite able to understand the superiority of the tropical parts of the globe, not only in the abundance and variety of their forms of life, but also as regards the ornamental appendages and vivid coloration which these forms present.

THE SEVEN TOWNS OF MOQUI.

BY E. A. BARBER.

AS early as the year 1540, Don Pedro de Tobar, one of the first Spanish adventurers, was dispatched by Coronado to the "province of Tusayan" (the modern Moqui, situated in Arizona, in longitude 110° to 111° west, and latitude 35° to 36°

north). The inhabitants were filled with great fear when they heard that a race of fierce men who rode horses (never having seen such animals before) had captured Cibola (ancient Zuni). "They, however, made some show of resistance to the invaders in their approach to their towns, but the Spaniards charging upon them with vigor, many were killed, when the remainder fled to the houses and sued for peace, offering as an inducement presents of cotton stuffs, tanned hides, flour, pine nuts, maize, native fowls, and some turquoises."[1]

Resulting from this visit of the conquerors, the Moquis or *Moquinos* were afterwards converted by the zeal of the Franciscans, but in the year 1680 they apostatized, and after massacring their instructors revolted, together with other Indians of the territory then included in New Mexico. At that time they drove out the Spaniards from their towns, and no attempt, since that event, has been made to reduce them again to submission.

In the latter part of the last century, about the year 1799, Don Jose Cortez wrote of them: "The Moquinos are the most industrious of the many Indian nations that inhabit and have been discovered in that portion of America. They till the earth with great care, and apply to all their fields the manures proper for each crop. . . . They are attentive to their kitchen gardens, and have all the varieties of fruit-bearing trees it has been in their power to procure. The peach-tree yields abundantly. The coarse clothing worn by them they make in their looms. . . . The town is governed by a *cacique*, and for the defense of it the inhabitants make common cause. The people are of a lighter complexion than other Indians. . . . The women dress in a woven tunic without sleeves, and in a black, white, or colored shawl, formed like a mantilla. The tunic is confined by a sash, that is usually of many tints. . . . The aged women wear the hair divided into two braids, and the young in a knot over each ear."

Although the foregoing descriptions were written more than three quarters of a century ago, they apply to the tribe, in every detail, at the present time. During our visit to these strange and isolated people in the summer of 1875, I was struck with the accuracy of some of the early Spanish writers in their quaint accounts which I had previously read. The names of the seven towns are subject to shades of variation in pronunciation at different times, because the tribe possesses no written language by which they might be permanently recorded; yet it is a curious

[1] See Essay by Col. J. H. Simpson, Smithsonian Report, 1869.

fact that we can recognize the majority of these almost unpronounceable names in the most ancient Spanish chronicles. For the purpose of comparison I append the following lists as given by different authors at various periods: —

According to Don Jose Cortez, an officer of the Spanish Royal Engineers, in his report sent to the king of Spain in the year 1799: —

O-rai'-be.
Xou-go-pa'-vi.
Gui-paul'-a-vi.
Mos-zas'-na-vi.
Gual'-pi.

———

Tau'-cos or Tan'-os.

According to Maj. J. W. Powell, in his exploration of the "ancient province of Tusayan," in the year 1869: [2] —

O-rai'-bi.
Shong-a-pa'-vi.
Shi-pau'-i-lu-vi.
Mi-shong'-i-ni-vi.
Wol'-pi.
Si-choam'-a-vi.
Te'-wa.

As given in the third volume of Pacific R. R. Reports by Lieut. A. W. Whipple, of the Corps of United States Topographical Engineers, in the year 1854: [1] —

O-rai'-be.
Shu-muth'-pa
Ah-le'-lah.
Mu-shai'-i-na.
Gual'-pi.
Shi-win'-na.
Te'-qua.

As collected by the photographic division of the United States Geological Survey, which visited Moqui in the year 1875: [3] —

O-rai'-bi.
Shung-a-pa'-vi.
Shi-pau'-la-vi.
Mu-sha'-ni.
Mo'-qui or Gual'-pi.
Si-chum'-a-vi.
Te'-qua (pronounced *Tay'-wah*).

Mr. Wm. H. Jackson, the photographer of the United States Geological Survey, returned to the Moqui pueblos during the spring of the present year (1877), and while there, an actual census was taken with the following results: —

	Men.	Women.	Children.	Total.
O-ray'-bi	160	145	195	500
She-mo-pa'-ve	61	56	72	189
She-pau'-la-ve	33	29	46	108
Moo-song'-na-ve	69	67	103	239
Gual'-pi or O-pe'-ki	90	80	164	334
Se-chum'-e-way	35	31	36	102
Te'-wa	44	32	56	132
Total,	492	440	672	1604

On an examination of these figures we shall perceive that the percentage of males is larger than that of females, and this fact may be accounted for by the unadventurous and pacific character of the men. They are therefore less liable to accident than the males of other tribes, and consequently the two sexes of this tribe retain to a greater extent their normal ratio. Polygamy, therefore, is rare among them, and polyandry is unknown.

[1] Mr. Leroux, about the year 1853, estimated the Moquis at 6720 population.

[2] About the year 1870 Mr. Beadle gave the population of the seven towns at 3000.

[3] The tribe in 1875 numbered between 1500 and 2000 souls.

If we allow, out of the nine hundred and thirty-two adults, the large proportion two hundred and sixty to be unmarried, we will have an average result of only two children in every family. The mortality of the race being much greater than the increase in population (being about equally divided between the two sexes) the Moquis are rapidly passing away. In the last quarter of a century there has been a decrease of five thousand in their entire number. After the lapse of the next score or so of years the race will most probably have become extinct.

HUNTING AMBLYCHILA.[1]

BY PROFESSOR F. H. SNOW.

IN considering the unintelligibility of the title of this paper to one who is not a professional entomologist, I am reminded of a brief dialogue which occurred between Mr. Foster, a member of my last summer's collecting party, and a cow-boy of the plains, who passed by one evening while Mr. Foster was looking for specimens. After watching him for some moments with great curiosity, the cow-boy asked: "What you doing?" Mr. Foster replied: "Hunting Amblychila." The cow-boy, bewildered, inquired again: "Ambly Cheila,—who 's she?" "Who she is" it will be the object of this paper in some measure to explain.

In 1823 the famous entomologist Thomas Say discovered a single dead specimen of this insect "near the base of the Rocky Mountains." Twenty-nine years later a second specimen, also dead, was found by one of the United States surveying expeditions. The remarkable structure and extreme rarity of this beetle made it "*facile princeps*" among American insects, and its possession was eagerly desired and earnestly sought by our foremost entomologists. But many difficulties lay in the pathway of those who would gain the coveted prize. The regions in which the two specimens had been captured were practically inaccessible to the entomologist. No railroad had then entered the vast country west of the Missouri River, and hostile bands of Indians were at all times in readiness to massacre the reckless adventurers who should dare to traverse their hunting-grounds without a powerful military escort. A national expedition for

[1] Read at the annual meeting of the Kansas Academy of Science, October 12, 1877, by Professor F. H. Snow, of the Kansas University.

the survey of our immense unoccupied domains might obtain the needed protection by government authority. But what professional "bug-hunter" could hope for membership of such an expedition, — much less aspire to the requisite military escort for an expedition of his own for the sole purpose of hunting an insect, however rare and however valuable in the estimation of entomologists?

But notwithstanding the inaccessibility of the plains to collectors of insects, several attempts were made to overcome this difficulty. A distinguished American entomologist, not many years after the discovery of the second specimen of Amblychila in 1852, issued a circular containing a description and life-size figure of the beetle, and distributed it among the army surgeons at the various military posts in the Western Territories. Several additional specimens were in this way obtained, and several others were brought in by some of the more recent government expeditions.

But *Amblychila cylindriformis* continued to be the rarest and the costliest of American Coleoptera. It could hardly be purchased for museums at any price, and not more than two years ago no less than fifteen and twenty dollars were eagerly paid for a single specimen. Indeed, a price-list of North American Coleoptera, issued at Cambridge only eight months ago, quotes the subject of this paper at twelve dollars per specimen.

Two causes, however, have recently conspired to bring out the fact that this insect is by no means the same rarity in nature as in entomological collections. In the first place the removal of the Indian tribes from Kansas soil to distant reservations has made it possible for the collector of insects to visit the plains without incurring the imminent danger of losing his scalp; and in the second place the discovery of the crepuscular and nocturnal habits of *Amblychila* has led to the capture of great numbers of specimens during the past season. This discovery, which had been predicted by Dr. Le Conte, was actually made in the summer of 1876 by Messrs. H. A. Brous and S. W. Williston of the Yale College Geological Expedition to Western Kansas, in charge of Professor B. F. Mudge. The members of this party obtained about one hundred specimens. During the present season several hundred specimens have been taken by Messrs. Williston and Cooper of the Yale Expedition, and by the Kansas University Expedition in charge of the writer. It is more than probable that the present year has been unusually favorable to the

occurrence of this insect, and that subsequent seasons may prove, like the season of 1876, less productive of specimens. It is a well-known fact that a species may occur in abundance for a single year and then become comparatively rare or altogether unknown for several years in succession. This law will doubtless be found to apply to Amblychila as well as to other insects.

I was disappointed to find this insect apparently devoid of that intensely ferocious nature which had been ascribed to it by sensational writers for the Eastern press, and which would be suggested by its position at the head of a ravenous family of beetles, the *Cicindelidæ* or tiger-beetles. I have watched these insects night after night coming forth from their hiding-places soon after sundown and beginning their night-long search for food. I am satisfied that their sense of sight must be exceedingly deficient, as they never discover their prey from a distance, however slight, and never capture it unless stumbling upon it as if by accident. When, however, they do thus stumble upon an unfortunate caterpillar, grasshopper, or other suitable article of food, a very acute sense of touch, chiefly concentrated in their long and constantly vibrating antennæ, enables them to seize upon and firmly hold it with their powerful, strongly-toothed mandibles, while with their maxillæ or secondary jaws they withdraw the life-juices and soft tissues of their struggling victim. They also manifest the imperfection of their vision by making no attempt to escape from their human captors, allowing themselves to be picked up as if entirely blind.

They are slow in their movements, walking about with great deliberation over their favorite hunting-grounds, the sloping clay banks. The only approach to rapidity of motion observed during the summer was in the case of a single individual suddenly surprised by the morning sun while at a distance from a suitable hiding-place, which he was making frantic exertions to discover.

In a brief article contributed to this Academy at our last annual meeting it was stated by Mr. Brous that these insects "live in holes generally made by themselves." My own observations do not corroborate this statement. On the other hand I found them invariably coming forth at night from holes made by other animals, — most especially from the intricately winding burrows of the kangaroo rat (*Dipodomys Philippii*), by which the clay banks are often completely honeycombed. In these burrows they take refuge from the direct rays of the sun in the day-time, in company with other nocturnal genera, — Eleodes, Pasimachus,

etc. These latter insects undoubtedly furnish many a diurnal meal for Amblychilæ, which are not to be supposed to pass the day in sleep. On one occasion I had an opportunity of watching two of them in a large, abandoned badger's burrow. They were wide awake, and walking about with vibrating antennæ as if in search of food. I have also kept several living specimens in confinement for several weeks, but never discovered any disposition to make excavations for themselves, though they would gladly take possession of holes made for them in the earth at the bottom of their cage.

In regard to food, no living insect seems to come amiss to them. They seem to be especially fond of all sorts of lepidopterous and orthopterous larvæ. I have seen them seizing and devouring the huge wingless locusts (*Brachypeplus*) and the sword-bearers (*Ensicaudes*). I observed one individual in the act of conquering and devouring the large Prionus of the plains (*P. fissicornis*), and in two instances have seen them eating one another, apparently with the greatest relish. In confinement they will thrive upon full-grown maple worms (*Dryocampa alba*), the caterpillars of the handmaid moth (*Datana ministra*), and upon almost every other insect pest of the orchard and garden.

But while thus visiting the death penalty upon every member of his class with which he comes in contact, our voracious hero is himself a choice article of diet to at least one carnivorous quadruped of the plains. Mr. J. M. Walker, one of the members of my party, while patroling his accustomed beat one morning before sunrise, discovered the fresh fragments of several half-eaten Amblychilæ scattered along his route, as if some predatory animal had but just preceded him and made his breakfast upon the rarities which otherwise would have found their way into the collecting-bottle. On the evening of the same day, Mr. Walker, while collecting in the same locality, was violently attacked by a rabid skunk twice in immediate succession. The next morning Mr. Foster, the other student of the party, was similarly attacked on a neighboring clay bank, and had the good fortune to kill his assailant. An examination of the contents of the animal's stomach disclosed the remains of freshly eaten Amblychilæ. It would thus appear that this ill-odored quadruped has an original claim to the title of Amblychila hunter, and is ready at the proper time to vindicate the claim against human contestants. This fact will merit the serious attention of entomologists who may

hereafter visit the plains, since the bite of the rabid skunk has proved fatal to man in more than nine cases out of ten, and there are more than fifty fatal cases on record. In this connection may be mentioned another danger which must be incurred by the collector of insects upon the plains. I refer to the bite of the rattlesnake, which venomous reptile abounds in Western Kansas and Eastern Colorado, and was encountered nearly every day by some member of our expedition.

REMARKS CONCERNING TWO DIVISIONS OF INDIANS INHABITING ARIZONA, NEW MEXICO, UTAH, AND CALIFORNIA.

BY DR. EDWARD PALMER.

HAVING traveled extensively in that part of the United States acquired from Mexico, and having examined the so-called ancient graves and mounds, as well as studied the Indians now living in the same region, I have come to the conclusion that this region was formerly inhabited by two divisions or classes of Indians, distinguishable by their modes of burial — one burning, the other inhuming, the corpses — and by their dwellings and domestic arts. In the same region are to be found graves which do not belong to the Indians now living there, and containing either the bodies or ashes of human beings whose epoch we have no means of determining.

The Indians found in the city of Mexico, and said by the Spanish historians to offer up human sacrifices to their gods, were only observing their usual custom of burning their dead. The Spaniards killed them in great numbers, and the Indians in burning the dead afforded their enemies, the Spaniards, the grounds for notions out of which to make religious capital. So the priests and officers magnified this simple custom, and by declaring the Indians to be idolaters and sacrificers of human beings they did them a grave injustice.

The Spaniards in their conquests always kept in view the maxim that the means justify the end. To ascribe the burning of the dead to offering up human sacrifices to gods was sufficient to gain the desired object, as the church would be aroused at once to send out missionaries to convert the heathen and establish religious orders among them.

Concluding that the Indians found living in the city of Mexico at the time of the Spanish conquest were Aztecs or crema-

tionists, if we go to that part of the United States formerly composing the frontier provinces of Mexico we find at this day pure Aztecs or cremationists; for those of the same race in the thickly settled and richer portions of Mexico have by one means or another been compelled to change from burning to burying their dead. While in Arizona we have the Apache, Mojave, Yuma, and Cocopah tribes, and in Nevada the Digger, which burn their dead, in California the Indians have so changed by church influence that nearly all bury their dead according to the rules of the Catholic church instead of burning the dead. Part of the Daigano tribe, after the expulsion of the Jesuits from Mexican territory, moved to the border of Lower California, and have gone back to all their old customs, burning their dead, and are now Indians in every sense; that is, they are free and untrammeled by any encroachments of the white man or his fashions.

The other division of Mexican Indians were those who buried their dead. They had only to drop their own mode of disposal of the dead and adopt that of the Catholic church. In order to observe the Indians of this division with customs unchanged, we must visit the Puma of Arizona, the Moqui and the Yuma Indians of New Mexico, for the other bands of this division adopt the Catholic mode of burial.

The cities and dwellings of the two classes of people in the country at the time of the Spanish conquest must have greatly differed. Yet the Spaniards called them all Aztecs. In this there seems to have been a design. The dwellings and cities were so exaggerated as to size and importance that in reading the reports sent to the Spanish court and the Pope one is led to conclude that they were of a grandeur and magnificence beyond all conception. But for Indians at that day or this to live in such a high degree of civilization is out of the question. Neither the ruins of former cities nor the style of the present buildings of their descendants supports those extravagant assertions. The statements of the Spanish priests were sufficient to make the Spanish government proud of its acquisitions, and in return its officers and the representatives of the church received great honors and rewards. The Spanish historians of the conquest of the city of Mexico tell us that the city was built on a marsh or wet land; for they say that ditches were cut to drain the city, and boats run up and down them. But how could magnificent buildings of great height, built of large blocks of

stone, be supported on a swamp, and how could they transport such large masses from the distance they had to be brought, without draught animals, — for they had no horses until the Europeans entered the country. Engineers have decided, after careful examinations of the foundation of the ancient city of Mexico, that buildings of the size spoken of by the Spaniards could never have been supported upon a marsh, as the foundations of the ancient city prove to have been; besides, if they did exist, some fragments would be found, as they could not be so entirely obliterated that not even a vestige would be left unless the pieces of sculpture and the calendar stone, which have been dug up in the city, may be considered to have belonged to the ancient city of Mexico. They may have been the ornaments of a Toltec building, brought by the Spaniards from some of the large Toltec towns with a view of sending them to Spain to give color to their reports, but owing to the difficulty of their transportation to the sea-coast at that day were left to be cast away, and resurrected years after as Aztec remains. Now, taking this view of the subject, we are led to the conclusion that the ancient city of Mexico was a collection of small one or two story houses made of adobe or sun-dried bricks, or in some cases possibly built of upright poles with sticks braced between and mud plastered over them. This kind of a house is frequently met with at this day, for round poles, sticks, and straw are used with a covering of clay for a roof. The people were not to be despised for living in these kinds of dwellings; their neighborhood afforded no other building materials, and their descendants of to-day live in houses made of like materials. Indeed, what else could the Apache, Mojave, Yuma, and Cocopah Indians use so easily and quickly as earth and poles, sticks and straw? Houses built of these materials answered all their wants.

The second division of Indians, those that buried their dead, were the Toltecs, neighbors to the Aztecs or cremationists. The dwellings of the former were superior to the latter, being confounded with and called Aztec. The Spanish conquerors reported these habitations as magnificent, in order to magnify their conquests. As superior as were the buildings of the Toltecs over those of the Aztecs, yet they were not of the grandeur reported by Spanish historians. Considering the Pimo Indians of Arizona, Moqui, Zuni, and the Rio Grande Indians of New Mexico, to be of the Toltec division, with the exception of the Pimos they live

in three-story buildings, — several families in a building, — and form a marked contrast to the Aztec buildings of to-day.

The ruins in the same country convey the idea that a similar kind of buildings inhabited by this class of people existed many years ago. The Pimos formerly lived in large buildings of several stories, and a good many persons in a building, but the Spaniards entered the country, and waged war with their Aztec neighbors, the Apaches; at the same time the Pimos acquired horses and arms from the Spanish, which also assisted them in coping with their enemies. The Apaches being thus placed in a condition to leave their communal dwellings, their lands became worn out. They now settled on a new tract of land close to their old homes, building small houses suited to each family. The reason that Indians live in communities is for better protection from their enemies. There seem to have been in the past as in the present periods constant war between the two divisions of Indians. The Aztec sbeing the most numerous and warlike and without fixed habitations, were an enemy to be feared, very difficult to conquer, and so tenacious of their freedom that the priests had to resort to force as well as to persuasion before any could be gathered into the church fold.

The Toltecs, being settled in communities in order to protect themselves from the Aztecs, were more easily influenced by the priests, and now most of them have adopted more or less of the Catholic religion. Heretofore the pottery found not only in the ruins and mounds of the country under consideration, but that scattered on the surface in fragments, has been considered by writers as the workmanship of the Aztecs; but the fact is that formerly, as at the present time, this pottery is made by the Toltecs, or burying Indians, and it is identical with that made by the same division of Indians to this day; while the Aztecs make a very rude class of pottery, which gives the impression that they may have borrowed the art of pottery-making from their Toltec neighbors. It is rough and of inferior ornamentation. The Aztec is superior to his Toltec neighbor in the art of warfare, and is a more successful hunter; on the other hand, the Pueblo or Toltec surpasses him in the architectural magnificence of his dwellings and in his superior mode of tilling the soil, and also in his systematic form of government. The advent of Europeans, the acquisition of horses, the establishment of Catholic missions, and the introduction of fire-arms among the Indians were no doubt the cause of most, if not all, of the modern changes

wrought among them. Those gaining horses and arms were enabled to wage war against their enemies. The church, being in harmony with the military force of the country during the Spanish and Mexican occupancy of the same, would send out a force of soldiers or conquered Indians, with horses and arms, to war upon the different Indians who were considered enemies, killing the men and bringing in the women and children, who were baptized, and thenceforth lost their tribal relations. Great numbers were thus gathered around missions, which so weakened various tribes that they would unite so as to be able to cope with their common enemies, the church or an Indian tribe. Both divisions suffered by like causes; and when a band of each of the divisions united, the customs of one would give way to the adoption of those of the other, or each would carry out the customs of both according to inclination. For instance, the bands of Paiutes will sometimes burn, at others bury, their dead, indicating that they are composed of both divisions of Indians. Or a band of each of these divisions of Indians may live side by side for mutual protection, and gradually adopt each other's customs, as is the case with the Maricopah Indians of Arizona, who soon after the Mexican war removed alongside of the Pimo Indians, for protection. Now they have nearly given up their custom of burning the dead, and adopted the custom of the Pimos, burying the dead. They have also improved in the art of making baskets and pottery, so that they can make an article equal to the Pimos.

It must be evident that the nature of the country which is occupied by a nation influences the manners, habits, and intelligence of the people. The ever-craving appetites of life, especially that of hunger, operating upon each individual cannot fail to give direction to his inventive habits, determine his pursuits, and impress upon him a character for all time. If the soil will yield grain or roots, or the rivers a plenty of fish, or if the mountains, valleys, and prairies are stocked with game, the course of an Indian's life day after day is thereby established permanently, for the wants of nature compel him to one fixed system of procuring food. The food question being all-powerful and not to be pretermitted, he is forced to become a hunter, a fisherman, or root-digger, in accordance with the nature of the country he occupies. Varied are the conditions of the soil and climate, as, for instance, that about the Moqui towns, which is so sandy and dry that they sow their seed so that it germinates in time to have the advantages of summer rains. All must stay

close to their crops to keep off rats or rabbits; for if their crops are destroyed, so dry and barren is the surrounding country that it affords few other natural products. On the other hand, the Apache lives in a country of mountains that yield game of all sorts, also seeds, roots, and fruit, with small but rich valleys in which he plants a little corn, wheat, etc. He need not stay close at hand to look after his crop, as nothing destroys it. He can roam and find plenty to eat until his crop is ready to harvest. Thus the Aztec is a wanderer, while the Toltec is a dweller in communities.

In comparing the asserted high civilization of the Indians at the period of the Spanish conquest with their present condition, we see a great difference, which can only be understood after taking into consideration the nature and productions of the soil, their want of domestic animals, cutting-tools, their means of cultivation of soil and their manufactures. One can come to no other conclusion than that the Aztec division in past years was the same as at the present day, with the exception of slight modification caused by wars and mixtures of the two divisions. The men of the Aztec division are lazier than those of the Toltec division, making their females do nearly all the work, while the Toltec takes a greater share of the work upon himself. The Aztec seems to have little power of thinking, makes no progress nor effort to amend his life, is fearless of death, bravely submits to his inevitable fate, and with stolid indifference awaits the swiftly coming doom of his people. The Spaniards made a mistake in confounding the two divisions. The Toltecs being the most industrious had more wealth and better dwellings, and were entitled to much consideration; but the Spaniards say less of them than of the inferior Aztecs.

The missionaries of the Catholic church, more than all other causes combined, changed the mental and physical condition of the Indians by humbling them to that state of servitude required by them to be members of that church: they broke their native pride, and those who succumbed to that degraded condition of settlers around a mission lost all self-reliance, so that at the expulsion of the Jesuits and the abandoning of the missions they were left helpless, their spirits broken; those who robbed them of their means of self-reliance had gone; after their homes and lands had been taken from them those who were left became an easy prey to the avaricious, who easily got them in debt, and then by a law of their own creating ever after held these people and their descend-

ants as peons or slaves, because they were never able to acquire money sufficient to liberate themselves. At the conquest Indians were slaves to the few, but afterwards to the many.

In admitting them to the church they were sprinkled, given a new name, and their hair was cut short. This seems the chief difference between the so-called Christian Indian and the so-called heathen Indian of that part of the country previously indicated.

In several parts of the country under consideration, ruins of dwellings and graves of both divisions of Indians are to be found side by side; especially is this the case in the valley of the Rio Verde, in Arizona. On the one hand are cave-dwellings, on the other stone buildings, in ruins. Who built up and occupied the caves, and who built and inhabited the stone structures? The Toltec division, which is proven by the articles found therein; the Aztecs waging war upon the Toltecs drove them from the valley and took possession. The Aztecs or Apaches claim them today, but do not now live in them, because their military enemies all around compel them to keep in the mountains. Recently they were by force compelled to move to reservations.

The Toltec dwellings in former times as now were built of sun-dried bricks or adobes if they were more easily made, but if stone was at hand then that was used, and when not broken into suitable sizes by natural causes stone hammers were used to reduce them. They were laid up regardless of joints; with either kind of materials they made very good houses. In this valley the Toltecs selected the best natural positions on elevated points, commanding a view of their fields below and of the surrounding country, so that they could not be attacked without a chance of seeing their assailants. The houses were generally of more than one story, and some appear to have been built with three.

In their graves with the dead is to be found pottery, etc., and about the dwellings is to be found much broken pottery of a quality that points to Pimo and Moqui origin.

The caves were used as dwellings during the summer, when they looked after their crops; but when the autumn set in fever and ague prevailed in the valley, the Indians removed to their houses, built of stone on the bluffs above the caves, safe from ague. The caves are natural excavations in the rocks, and well adapted for Indians' dwellings. The Aztecs drove the Toltecs out of this valley, and built themselves houses of sticks covered with straw and mud, a contrast to the large, airy dwellings in

the caves and the stone buildings on the bluffs. Many caves are to be found in the country, and they appear to have been occupied by the same people, the Toltecs. The Aztecs left many grave-yards, which are distinguishable by piles of stones, generally of a circular form, but with no regularity as to distance apart. In one, particularly, I noticed a number of graves arranged into some degree of order, being in nearly straight rows and several in a row, with stones piled on top lengthwise as if to indicate the height of the deceased when living; but in both these kinds of graves there was nothing beyond ashes and pieces of human bones placed nearly in the centre.

The ruined cities built of adobes in the provinces of Durango and Chihuahua, Mexico, are like the seven cities of Civola, or towns of the Pueblo Indians of New Mexico, mentioned by the Spanish, who speak of the great wealth of the people living in them; if they were formerly wealthy they are not now, and the quality of the soil must have changed and more water must have flowed over the surface. These people in early days had no domestic animals, so they must have depended upon the soil of their immediate neighborhood for whatever they possessed. Now it is a dry, sandy waste, and these people can scarcely obtain the plainest living, much less gain the wealth spoken of by the Spaniards.

The people of these seven towns, as all those inhabiting that section of country under consideration were called by the Spaniards Aztecs, despite the wide differences between them. They seemed to have no other idea than to make these people appear great, powerful, and wealthy, in order to gain the favorable consideration of their king, on the one hand; and to make them to appear great idolaters, offering up human sacrifices to their gods, on the other hand, to please the church. But I have not been able to find any indications of idols among them other than what they have derived from the missionaries. They have many dolls made of clay by the females for the children to play with, and for no other purpose, many of which have been taken away and called gods. I have seen them in museums marked as coming from these people.

The church has tried to impress upon the Indian mind a reverence for a Montezuma whom they were taught would come some day, if they were good, to rule them, and historians say he lived and ruled the city of Mexico. If he had been a great ruler, and the impression had ever been conveyed to Indians by natural

causes that he was to come in the future to rule over them, they would be likely to have a remembrance in some legend, but none of the Indians living in the section under consideration seem to know anything themselves regarding Montezuma. We are also told by historians that the Indians mount their house tops in the mornings and turn towards the east and look for Montezuma; this I have never seen, though I have visited several of their towns. In questioning the oldest, who are the most reliable, regarding Montezuma, in every instance I have been told that Montezuma was a Spanish not an Indian god; they knew nothing of him except what the Spaniards taught them. Among the Daigano Indians of Hot Springs, California, are two that remembered the first missionaries that came among them. They were then about half grown, and remembered well the events of that period, though they are now very old. Among the many questions I asked them was the following: What was your mode of burial before the Spaniards came among you? They answered, "We burnt our dead." Several others of the same place said the same thing. To the question, Do you know anything of Montezuma? the oldest two, as also several others, answered, "Not of ourselves, but the Spaniards told us about him. He is a Spanish god." On visiting a band of the same Indians living on the border of Lower California, and having with me a Spaniard as interpreter, on entering a house the first thing that he saw was a doll made of clay (Indian mothers make them for their children and burn them as they do earthern ware). He cried out, "There is Montezuma, the Indian's god." At this a venerable man rose up, and with anger in his face said, "No Indian god; Montezuma is Spanish god." On my questioning several of both sexes upon the same subject, all asserted that Montezuma was a Spanish and not an Indian god. Among the mission churches, rendered as attractive as possible to please the Indians, many strange customs and ceremonies crept into the form of worship. A special saint was created for the Indian's benefit, to watch over him. If he has benefited by all the church has done for him, then retrogression must have a new meaning. The influence of the church and the extensive system of intermarriage by the Spaniards have so changed both divisions of the race held under their dominion, that we have an amalgamated variety different from both and very inferior to either, especially to the Toltecs.

As to where the Indians came from that have in former days and do now live in the country acquired from Mexico I will not

say, but will only remark that the cremationists or Aztecs look like Japanese, while the Toltecs or burying Indians look more like Chinese, not only in similarity of features but in manners and customs. The reserved and uncommunicative disposition of both certainly indicate a common origin.

If a close study were instituted among all the present tribes of Indians in the United States and Mexico, proof would no doubt be adduced which would determine to which of the divisions they belong, the Toltec or Aztec, — if of pure blood or a mixture of the two; and if inquiry were made as to the causes which led to the unity, it might also lead to the conclusion that all the tribes are offshoots of the two divisions. Certainly the Mandans and the so-called mound-builders belonged to the Toltec, while many of the Texas Indians appear to be Aztec in their origin. May not all American Indians be Chinese and Japanese under another name?

The early Spaniards may be somewhat excused, perhaps, for many of their exaggerations. They themselves were not so advanced then in agriculture, architecture, and the domestic arts as they now are; and when they beheld a strange land with a new people so advanced, they, comparing them with themselves, concluded that the Mexicans were a great people, as they were considering their surroundings and tools and materials to work with. They were great, both divisions of them. The fault was in exaggerating their wealth so as to be the gainers thereby, and making them out to be what they appear not to have been, idolaters, so that they might excite the zeal of a religious denomination to locate among them and to force upon them a new set of customs which would be the cause of their degeneration. It could scarcely be expected of the early historians that they would study the Indian character with the view of ascertaining the particular differences between them, as they were looking at them with a view to their own reward, and without any consideration of the Indian's material welfare or history. Whether Aztec or Toltec, by far the larger number soon became hewers of wood and drawers of water for the mission establishments or for a few Spaniards. The latter made wealth at the expense of the lives of thousands of Indians of both sexes, who were worked to death in mines, on farms, and in various occupations. The great aim of the rich was to be idle and to compel the poor to labor to make them rich.

The efforts of the missions were to have the rich subservient to them, so that nothing could be done by them without the sanc-

tion of the church. So the church owned the rich, and the rich owned the poor. Thus it was until Mexico became a republic and the church lost its power. Since the United States acquired that part of the country under consideration the Aztecs and Toltecs have been left to choose their own manners and customs, except those that have already become peons, who were under the authority of their owners, and so remained until after the late war, when the Congress of the United States passed a law abolishing peonage or servitude for debt.

The published accounts by the early Spanish historians have been copied by most modern historians as if they could be anything but inaccurate; few imply even doubt as to the truthfulness of the accounts. But if they had visited the country and seen the nature of the soil, the climate, and natural productions at the present time, and then looked back at the Indian without modern tools, machinery, domestic animals, modern fire-arms, clothing, and introduced grains, etc., and left out of sight the Europeans and their customs, the historians would have copied much less from old authorities. The actual condition of the Indian and his surroundings before he was at all tampered with by Europeans, when impartially viewed, will compel any one to adopt different conclusions from the old chroniclers.

Let us consider the descriptions of what they are pleased to call Montezuma's palaces and his entertainments of Cortez and his followers. There is scarce a European monarch that could produce more pomp and extravagance. Only contemplate the feasts of the reported magnitude gotten up by the Aztecs! They could not have had houses large enough, nor is it possible for a rude people with their native resources to have obtained the variety and quantity of articles said to have been used by the reputed Montezuma to feed the Spaniards; it would take but a short time to eat out an Indian community, with only their native mode of farming; it would require more executive ability than is generally possessed by even the smartest of the Toltecs, much less the Aztec Indians, to carry on an establishment of the character of that attributed to the so-called Montezuma. Consider what it must take to feed the army of servants he is said to have had; then the wealth he gave to the Spaniards and that they took by force. One can come to no other conclusion than that the Indians have sadly degenerated since that time, for they could not bring forth food or wealth at this day as they are said to have done at the conquest. There is something unnat-

ural in an Indian, however great he may be, having so great a number of followers about him. Indian men especially are so adverse to servitude that it is doubtful if so large a number could be held for that purpose; they would revolt, and who could prevent it? These volunteer servants would belong to almost as many different families, and it is nearly a universal fact that if one of a family is offended with any one the whole family take sides with him. An Indian's family comprises all his relations; so all the relations and servants of the supposed Montezuma would form a powerful army to withstand.

To give a more truthful version would be simply to state that a large number of Aztec Indians lived in the city of Mexico at the time Cortez made his appearance. They were governed by a chief who had a few hangers-on, as all chiefs have; generally his relations lived around him. Chiefs of both these divisions under consideration are required to procure their own provision, that is, his wives and children do. A chief is estimated by his wealth. I have never observed anything like tribute or taxes being collected by a chief. Presents are not only given but received by the chiefs.

One thing is certain: both the divisions of Indians when one dies let him be either burnt or buried; everything that the dead possessed or his friends had, even to his clothing, is thrown upon him to be either consumed with him or be put with him in the grave. This is a great barrier to the accumulation of property, for not even money or ornaments, however valuable, are withheld from the dead. The living relatives march from the last resting-place of the dead or from their ashes with nothing. The dead have it all, and the living will not go near the spot again or mention the name of the dead; it is so with both divisions. This would warrant the conclusion that they care not to convey events to history. A great deal is said about historical representations on rocks. I have seen the present Indians make representations on rocks like the so-called hieroglyphics, and I have invariably been told by them that they were made only for fun, and had no meaning.

It is very difficult to reconcile the accounts given of the people living in the city of Mexico at the time of Cortez's appearance with any of the present Indians. One of two conclusions may be adopted: if the people of the city of Mexico belonged to either of the two divisions of Indians, then there has been wonderful degeneration among them; or possibly those found were a special

creation attended with all the wealth and display for the purpose of honoring the captors of Mexico, and destined to disappear as soon as the crafty conquerors had accomplished their object.

NOTES ON THE BREEDING HABITS OF THE GOLDEN-WINGED WOODPECKER.

BY DAVID A. LYLE, U. S. A.

ON the afternoon of May 6, 1877, as I was strolling among the trees in the lower part of the Armory grounds, at Springfield, Massachusetts, I heard the faint hammering of a woodpecker (*Colaptes auratus*). Listening intently for some moments to ascertain, if possible, the direction from whence the sounds came, I proceeded onward with the stealthy tread of the Indian, — learned long since in the wilds of the far West. After advancing in this noiseless manner for some rods, I again halted and turned my ear successively in different directions the better to catch the faint sounds made by the industrious feathered artisan. Again I heard the rapping, and satisfied that I was traveling in the proper course I advanced some distance farther in the same quiet manner, and upon listening attentively for about a minute I was rewarded by hearing the sounds much more plainly.

I now redoubled my caution, following the sound more and more slowly for fear of alarming the shy worker. At last, I directed my attention to three trees, in one of which I was convinced that the woodpecker was working. The muffled sounds indicated that the bird had already penetrated the trunk of the limb or tree in which the nest was to be made. Carefully I approached the first tree, and placing my ear in contact with the trunk I awaited a repetition of the hammering. Again I heard it, but no more audibly than before reaching the tree. I tried the second tree with better success, for by pressing my ear against the trunk I could hear the thumpings very distinctly indeed. Now I was sure that I had found my bird, which conclusion was strengthened by finding among the grass near the foot of the tree quantities of small, fresh chips which the bird had ejected from his newly located domicile.

These chips were scattered over quite an area in the vicinity of the tree. On stealthily retreating from the roots of the tree in the direction indicated by the chips, I saw the hole bored by the object of my search. It had been screened from my view

by some branches which were just leaving out. The hole was situated near the top of a tall stump of sugar maple, the upper part of which had been carried away by some wind-storm.

I laid down upon my back on the ground, in order to command a better view of the hole, and for fifteen minutes I neither saw nor heard anything. I suppose the bird had heard some sound. Patiently waiting during this time, I at last discerned the side of his bill near the lower edge of the hole. Then he raised his head a little, so that his side and bill were visible, and watched with this eye for nine minutes by my watch, remaining motionless during the whole time. At the end of this interval he dropped to the bottom of his hole and a minute later his head appeared; glancing warily around, he thrust it out and I saw he had a bill-full of chips; these were protruding on both sides from between his mandibles. With a flirting motion of his head, he scattered the chiplets in the air, and gazing around for a moment he disappeared in his hole.

This operation he repeated several times, always reconnoitring the vicinity before and after disposing of the chips brought up. A couple of boys passing just as he had thrown out a load of chips, he dropped to the bottom of his nest in haste, and not a sound was emitted for another fifteen minutes, when a part of his bill was again visible as he came up to see whether or not the enemy had withdrawn. Five minutes later he put his head out of the hole, glancing quickly in every direction. This series of observations lasted for five minutes, when he disappeared, and in an instant reappearing he emerged from the hole and perched upon a limb about a foot from it. Here he stood for five minutes more, though it appeared to be much longer, and then flew to a high tree about fifty yards distant, where he rested for a moment, and then vanished among the trees. The female was not seen upon this occasion. On May 27th the female was found incubating, and the male was seen upon a tree some distance away, apparently cheering her by an affectionate call.

On referring to my note-book, I find the following under date of May 27th: —

"A little over two weeks ago, my attention was attracted by the appearance of a second pair of these beautiful woodpeckers upon the trees in the Armory grounds. They were very shy, but were evidently pairing. The female would fly from tree to tree, where the male would follow her, uttering a peculiarly low, cooing, assuring cry. This note, or rather succession of notes, is

heard only during the mating season. Very early a morning or two later, I found them upon a tree, quite near together. The male was very demonstrative in his love-making. At short intervals, he would droop his wings slightly, spread his tail, nod or bow his head towards the female, first to one side and then to the other, all the while uttering his low love carol. She reciprocated his bows, bowing every time he did, but uttering no note that I could detect.

"The affectionate anxiety of this feathered Adonis to appear well in the eyes of his mistress seemed most ludicrous to the beholder, while at the same time there was such an air of loving tenderness and devotion in both his voice and actions that the sympathy of the spectator was at once enlisted for the success and happiness of so gallant though so awkward a wooer.

"This courtship continued for about one week, during which time the happy pair had fixed upon the site for their future home. This they located upon the dead limb of an elm, sixty feet from the ground. The tree stood at the side of a much-traveled road and near some shops. Here their troubles began.

"Again, the truth of the old adage 'that the course of true love never runs smooth' was vindicated. For in a tree near that chosen for their future nest resided a colony of English sparrows, whose pugnacity is well known. The paucity of leaves on the trees exposed the handsomely colored woodpeckers to the danger of discovery by their fiery little enemies, the moment they alighted upon their chosen limb. No sooner did our woodpeckers begin the operation of outlining the hole for the entrance to their domicile than they were furiously assailed on all sides by the enraged sparrows.[1] The woodpeckers would awkwardly dodge their blows and get on the opposite side of the limb, but the sparrows returned again and again to the attack, until the woodpeckers would seek safety in flight. Still the devoted pair did not despair. Time after time would they return and work a little while until discovered by their sharp-eyed enemies, when they would again take refuge in flight. At the end of a fortnight the leaves had come out sufficiently to screen them from the view of the sparrows, but as people and teams were constantly passing the tree, their shyness kept them retreating almost every few minutes. This morning I find one of them busy chiseling away at the hole."

[1] So it seems that the flicker is to be added to the long list of birds which these wretched interlopers attack and harass. Dr. Thomas M. Brewer has so long persisted in his denial of the facts, in the face of testimony no less explicit, that it is a question with me whether he will not pooh-pooh this away too. — Elliott Coues.

A week later their arboreal home had so far progressed that they could enter and be screened from the view of their vexatious little enemies. Here they worked and delved — if I may be allowed the term — for another week to secure the proper depth. The ground for several yards around the tree was strewn with the tiny, white chips brought up at intervals and cast to the winds with that peculiar flirt of the head and bill which is characteristic of this avian family. About the middle of July, I found both parents busily occupied in searching the trunks and limbs of trees for larvæ and worms to feed their young. During and after the period of incubation, the familiar notes of this bird were rarely heard except very early in the morning. The first week in August both families of woodpeckers disappeared and have not been seen since.

RECENT LITERATURE.

COPE'S VERTEBRATE PALÆONTOLOGY OF NEW MEXICO.[1] — The present volume of nearly four hundred pages of text and upward of sixty plates comprises Professor Cope's final report upon the vertebrate palæontology of New Mexico to the Wheeler survey. The species here described and figured have in greater part been previously characterized in various preliminary papers published by Professor Cope during the last three years; they are here treated more in detail, with the addition of nearly one thousand excellent figures. The volume hence takes rank as one of the most important contributions to North American vertebrate palæontology that has yet appeared. Among the results attained are, as announced by the author, "the elucidation of the structure of the western slope of the Rocky Mountains and the plateau to the westward of them, in Northwestern New Mexico;" "the determination of the fresh-water character of the 'Triassic' beds in that region;" "the discovery of extensive deposits of the Lower Eocene, equivalent to the Suessonian of Western Europe;" "the determination of the faunæ of four periods, in basins which had not previously been explored, namely, in the Trias, the Eocene, the Loup Fork Epoch, and the Postpliocene of the Sandia Mountains." The number of species of extinct vertebrata "obtained during the season of 1874," and described in the present report, are "? Triassic, 4; Cretaceous, 13; Eocene, 87; Upper Miocene (Loup Fork), 30; Postpliocene, 2;" making a total of 136 species. The

[1] *Report upon United States Geographical Surveys West of the One Hundredth Meridian.* In charge of First Lieut. Geo. M. Wheeler, Corps of Engineers U. S Army. Vol. IV. Palæontology, Part II. *Report upon the Extinct Vertebrata obtained in New Mexico by Parties of the Expedition of* 1874. By Prof. E. D. COPE. 4to, pp. xii., 370; pls. xxii.–lxxxiii. Washington. 1877.

greater part of the remains on which this report is based were collected by the author himself, who thus had the opportunity of becoming familiar with their stratigraphical relations.

In discussing the character of the great Eocene plateau of New Mexico, first explored by Professor Cope in 1874, it is claimed that the Tertiary mammalian fauna originated through a migration from the southward, replacing the Mesozoic type of Saurians which had until then occupied the field. "New Mexico," he concludes, "was then no doubt the source from which the fauna of Wyoming was derived, and the extension of the Wahsatch [or Green River] fauna probably proved fatal to the latest representatives on the American continent of the dinosaurian and other reptilian forms of Mesozoic time."

The work before us is divided into three chapters: the first is devoted to the Fossils of the Mesozoic Periods and the Geology of the Mesozoic and Tertiary Beds; the second to the Fossils of the Eocene Period; and the third to the Fossils of the Loup Fork Epoch. The Mesozoic vertebrata described embrace a single species of fish allied to the *Mugillidæ*, a large crocodilian, and a large, "probably terrestrial" animal, "with powerful fore and hind limbs subequally developed," called *Dystrophæus viæmalæ*, of doubtful class affinities. The Eocene types include several forms known also from the Cretaceous and Tertiary, and the Lepidostoid genus *Clastes*, known thus far only from the Eocene of the Rocky Mountains. The reptiles are more numerously represented, and embrace turtles, crocodilians, and ophidians. Of the six genera of turtles three (*Trionyx*, *Dermatemys*, and *Emys*) still exist. The several species of crocodiles are referred (some of them doubtfully) to the existing genus *Crocodilus*. The only bird described (*Diatryma gigantea*) was of large size, the single tarso-metatarsal bone, by which it is thus far known, having a breadth at its proximal end "nearly twice the diameter of that of the ostrich. Its discovery introduces this group of birds to the known faunæ of North America, recent and extinct, and demonstrates that this continent has not been destitute of the gigantic forms of birds now confined to the southern hemisphere faunæ." It is considered as allied to *Gastornis* Hèbert of the Eocene of France. The mammalia of this period are numerous, amounting to fifty-four species. Of these, ten are referred to the order *Perissodactyla*, eight to the order "*Amblypoda*," thirty to his new order "*Bunotheria*," and three to the order *Rodentia*. Space will not permit of more than a brief notice of these groups, the affinities and characteristics of which, and their various subdivisions, are discussed in detail. The *Bunotheria* were abundantly represented during the North American Eocene, during which period they "fulfilled the functions of the existing *Carnivora*." While they agree quite nearly in structure among themselves, they differ in important particulars from the true *Carnivora*. They are described as varying from the size of a weasel to that of a jaguar. Some of the puzzling forms

here brought together were at first referred to the *Carnivora*, others to the lemurine *Quadrumana*, others to the *Insectivora;* others still have been supposed to have ungulate affinities, and others constitute Professor Marsh's order *Tillodontia*. Professor Cope considers that his order *Bunotheria* cannot be defined so as to separate from it the existing Insectivora. Under this ordinal name he hence includes the existing *Insectivora* as a suborder, and considers that further investigations will be necessary to determine the relations of the *Prosimiæ* to this order. The *Bunotheria* are divided into five suborders: *Creodonta*, *Mesodonta*, *Insectivora*, *Tillodonta*, and *Tæniodonta*, which subdivisions are regarded as not more heterogeneous than those of the *Marsupalia*. The affinities of the *Bunotheria* are very divergent. While the *Insectivora* maintain their typical characters, the Tillodonts show a certain kind of affinity with the Rodents, and the Tæniodonts present "a point of connection with the Edentates," — the first hint of relationship between this anomalous order and the other mammals. The Mesodonts are apparently related to the Prosimiæ and Quadrumanes, as are the Creodonts to the Carnivores. If these interpretations prove to be correct, we have in the Bunotherians an extensive early generalized group foreshadowing the later more specialized mammalian orders of the present day. To this group are referred many of the mammalian genera of the early Eocene of Europe, as well as the Wahsatch and Bridger faunæ of the early Eocene of North America.

The order *Amblypoda* is regarded as the most generalized order of hoofed mammals, "being intermediate in the structure of their limbs and feet between the *Proboscidia*, the *Perissodactyla*, and the *Artiodactyla*," which fact, "together with the small size of the brain, places them in antecedent relation to the latter, in a systematic sense, connecting them with the lower mammals with small and smooth brains, still in existence; and in a phylogenetic sense, since they precede the other orders in time, they stand in the relation of ancestors. It is doubtless true that the *Amblypoda* were the ancestors of all living ungulates, although no genus of the latter can yet be traced to any known genus of the former, such genera remaining for future discovery." The proportional size of the brain, as shown by Professor Marsh, in respect to the *Dinocerata* (referred by Cope to the *Amblypoda*) is more like that of reptiles than of mammals, and another reptilian feature is seen in the immovable tibiotarsal articulation, — hints merely of a very remote reptilian relationship. Two suborders of this group are recognized, *Pantodonta* and *Dinocerata*. To this order is referred the genus *Coryphodon* Owen (*Bathmodon* Cope), several species of which are here described in detail, together with an account of the milk dentition.

The *Perissodactyla* are represented in the Wahsatch Eocene by comparatively few species, all of small size, but some of them were numerously represented in individuals. They belong chiefly to the genera

Orotherium Marsh, and *Hyracotherium* Owen (to which latter Cope refers *Orohippus* Marsh). *Hyracotherium* has several near allies, both in the Old World and the New, and is here treated not only as a Perissodactyl, but is considered as having ancestral relations to the Equine series.

Passing over the interesting Review of the Characteristics of the Vertebrate Fauna of the Wahsatch Eocene of New Mexico (pp. 269–282), we have space for only a very brief notice of the chapter devoted to the fossils of the "Loup Fork Epoch." Among these are described two species of tortoise (*Testudo*), and one bird referred to the genus *Vultur*. Of the mammalia three are Rodents, three Carnivora (one referred to *Putorius* and two to *Canis*, one of the latter, *C. ursinus*, as large as the black bear), one Proboscidian (*Mastodon productus*), four Perissodactyls, and eleven Artiodactyls. The latter belong chiefly to the cameline group (genera *Merychyus* Leidy, *Procamelus* Leidy, and *Phlianchenia* Cope) and partly to the peculiar deer-antelope type here referred to *Dicrocerus* Lartet (*Merycodus* and *Corsoryx* Leidy), a probable progenitor of the deer tribe (*Cervidæ*).

The Loup Fork beds have been commonly viewed as representative of the Pliocene of France, although their exact synchronism has been considered as doubtful. Professor Cope believes that the general facies of the Loup Fork fauna indicate an earlier age than this, and that the Pliocene of America remains yet to be defined. The Loup Fork fauna is characterized by an absence of fishes and crocodiles, from which it is inferred that the "formation is that of a marsh and not of a lake." The fauna has been studied at three widely separated localities in the region west of the Mississippi River, between the strata of which there is a near lithological resemblance, and the fauna collectively presents a common character as distinguished from that which preceded and followed. It is hence isolated alike from the Quaternary and the White River epochs. Only three of the genera have living representatives, one of which (*Canis*) also occurs in the White River beds.

In conclusion may be noted the growing tendency to a recognition of the generic identity of a considerable proportion of the Tertiary genera of North America with their European representatives of approximately corresponding age.

The Wild Flowers of America, Part II.[1] — The second part of the present work includes plates of *Iris versicolor* L., the common blue flag; *Rudbeckia columnaris* Pursh, the columnar cone-flower; *Viola sagittata* Aiton, the arrow-leaved violet, accompanied by a figure of *Carex Pennsylvanica* Lam.; and *Steironema lanceolatum* Gray, the lance-leaved loosestrife. The latter plant is more familiar to our botanists under the older name of *Lysimachia lanceolata*. The four plates are beautifully

[1] *The Wild Flowers of America.* Part II. Illustrations by Isaac Sprague. Text by George L. Goodale, M. D., Assistant Professor of Vegetable Physiology, and Instructor in Botany, in Harvard University. Boston: H. O. Houghton & Co.; New York: Hurd & Houghton.

executed and quite equal to those in Part I., although none of the species in the present number are as picturesque as *Aquilegia Canadensis* L., previously figured. The plates of the loosestrife and the arrow-leaved violet seem to us to be most successful as far as the accuracy of the representation is concerned. The most beautiful plate is that of the iris, which could be surpassed only by nature itself, for, in the species of this beautiful genus, such is the delicate shading of the colors and the exquisite translucence of the standards and the stigmas that art, at the best, must fall a little short of nature. With regard to the figure of *Carex Pennsylvanica* which accompanies the *Viola sagittata* we would suggest that its botanical value would have been enhanced had a matured spike also been figured. The descriptive text is shorter than that in Part I., but in *Viola sagittata* and *Iris Virginica* Professor Goodale has found material for some very interesting remarks on cleistogamous flowers and insect fertilization. In the present fasciculus the plates are not stitched but folded in the cover. In this connection we must express the hope that the publishers will give the public the opportunity of purchasing extra copies of some of the plates for framing, as we can think of no more appropriate ornaments for a school-room or lecture hall than the beautiful plates of this series. — W. G. Farlow.

GENERAL NOTES.

BOTANY.[1]

Fertilization of Flowers by Birds. — From recent mention of this subject in Mr. Darwin's new work, and in a review of it by Dr. Gray in the *American Journal of Science*, and two notes in *Nature*, I conclude that but few instances are known in which birds visit flowers. In the United States Dr. Gray names honeysuckles and trumpet creeper, in addition to *Impatiens*, which Darwin gives on authority of others.

The ruby-throated humming-bird is common in this State and is frequently seen about our flower beds and in the green-house. I have often seen it visiting lilacs, phlox Drummondii, perennial phlox, portulaccas, petunias, morning-glories, roses, honeysuckles, snapdragons, fuchsias, and I think many other species of which I have made no note. Several of the above were given me also by the gardener, Mr. Cassidy. He also had noticed that the birds came in through the ventilators of the greenhouse in spring to visit the fuchsias, of which they seem very fond, but after spring flowers appear their visits are less common. Again they frequent the flowers in the greenhouse in times of dry weather. I have not made as many notes on this subject as I now wish I had, but I am quite sure it will turn out that they visit a large number of species of our wild and cultivated flowers. They visit them with much greater rapidity than is common with the honey-bee. — W. J. Beal.

[1] Conducted by Prof. G. L. Goodale.

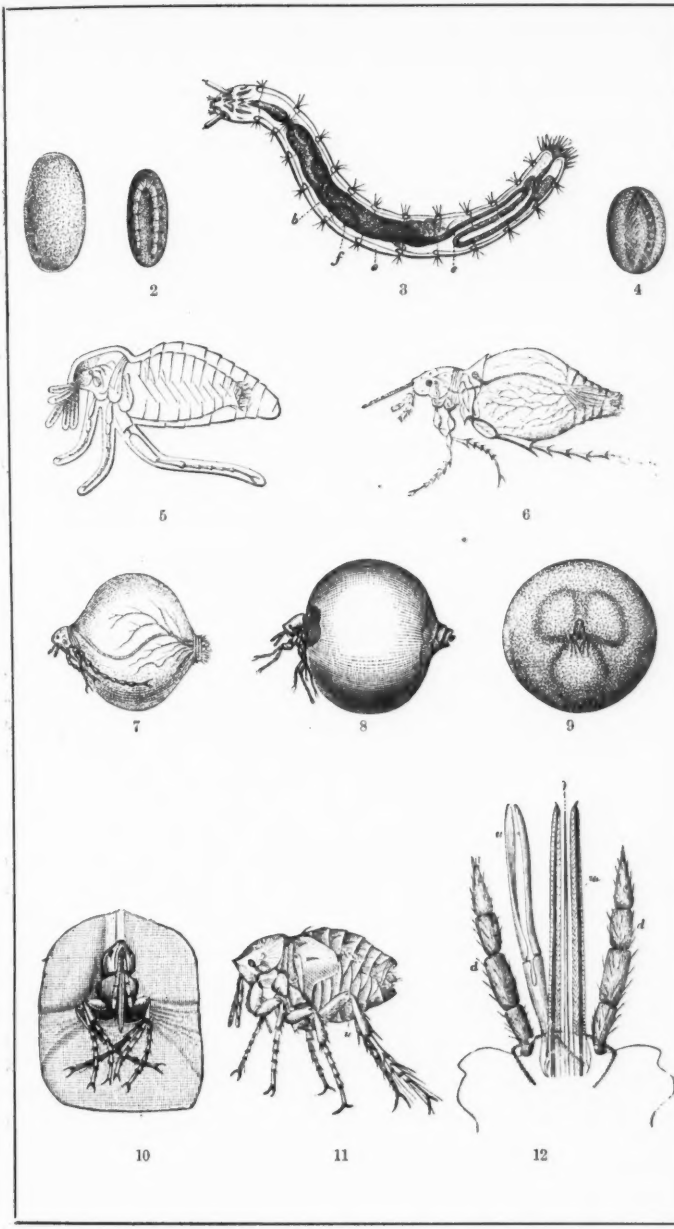

PLATE III. METAMORPHOSIS OF THE JIGGER FLEA.

ZOÖLOGY.[1]

The Jigger Flea. — The jigger or chigoe, a species of flea (*Pulex penetrans*) which burrows in the feet of men in tropical America, has within late years been studied by Karsten, Guyon, and Bonnet. Our figures have been taken from these works, and were originally used to illustrate the Danish *Journal for the Popular Diffusion of Natural Science.* The eggs (Plate III., Figures 1, 2) are either dropped upon the ground, or remain within the sacs of the gravid female. The larvæ (Figure 3) transform in a cocoon (Figure 4) into the pupa (Figure 5), as in the ordinary flea. Figure 6 represents the fecundated female; Figure 7 the same at the third day from its entrance under the skin; Figure 8 the same after several days' residence in the skin of its host. Figure 9 represents the fully grown female, seen in front and magnified only four times; Figure 10, the head of the same still more enlarged. Figure 11 represents the female before it has entered the skin of its host, and Figure 12 the mouth parts, much enlarged (*w*, mandibles; *d*, maxillary palpi; *u*, under lip or labium).

ANTHROPOLOGY.

Anthropological News. — Some account was given in our last number of anthropological papers read at the American and at the British Association. The following are some of those communicated to the French Association: Déformations crâniennes occasionnées par la Syphilis héréditaire (discussed at great length), Parrot; Announcement of the Plans for the Anthropological Exhibition at Paris in La Palais du Trocadero (*Revue Scientifique*, No. 9, 1877, p. 204); Mémoire sur les Accumulations de Silex, M. de Puligny; La Nomenclature des Légendes anciennes, M. Daleau; Considérations sur l'Age du Bronze en Hongrie, M. Hampel; L'Age de la Pierre chez les Nègres, M. Hamy; Démographie de la Seine inferieure, Mariage, Natalité, et Mortalité, Dr. Bertillon; L'Homme à l'Époque du grand Ours des Cavernes, M. Ollier de Marichard.

GEOLOGY AND PALÆONTOLOGY.

Recent Palæontological Discoveries. — Professor Cope recently announced the discovery by Mr. C. M. Wheatley, in the trias of Pennsylvania, of a large saurian, which he named *Palæoctonus Appalachianus.* Since that time Mr. Wheatley has obtained material which demonstrates that the reptilian life of that period in the East was rich in types. This includes teeth of two other individuals of the saurian named, and teeth of six other species. Two of these, the *Belodon priscus* and *B. Carolinensis*, had been previously known, while three others of larger proportions are new to science. They have been named

[1] The departments of Ornithology and Mammalogy are conducted by Dr. Elliott Coues, U. S. A.

Clepsysaurus veatleianus, *Suchoprion cyphodon*, and *Palæoctonus aulacodus* by Professor Cope.

William Gurley, of Danville, Illinois, has recently added some interesting species to those already known to occur in the bone bed discovered by Mr. J. C. Winslow. Such are two new species of *Cricotus* (Cope) and an allied new genus, *Lysorophus* Cope. A second new genus is said to be allied to the salamanders, and is called *Diplocaulus*. Mr. Gurley finds also a new *Ctenodus*, *Orthacanthus*, etc.

Since his discovery of the *Camarasaurus* in Colorado, Mr. Lucas has obtained the bones of a number of other reptiles, some of them little inferior in proportions to the *C. supremus*. One of these, of herbivorous type, is described by Professor Cope, in the Proceedings of the American Philosophical Society, as *Caulodon diversidens*. A huge carnivorous species receives the name of *Lælaps trihedrodon* Cope, and a smaller type, with hollow biconcave vertebræ and neural arch united by suture is referred to the new genus *Tichosteus* with the name *T. lucasanus* Cope. A species of Emydoid tortoise without dermal scuta, and with solid plastron and marginal bones is called *Compsemys plicatulus*. It is the oldest of the order Testudinata yet found in North America.

GEOGRAPHY AND EXPLORATION.

Geographical News. — Among papers of interest in the forty-sixth volume of the *Journal of the Royal Geographical Society of London* are the following: On Mr. H. M. Stanley's Exploration of the Victoria Nyanza, by Lt. Col. J. A. Grant. The North American Boundary from the Lake of the Woods to the Rocky Mountains, by Capt. S. Anderson. The Valley of the Tibagy, Brazil, by T. P. Bigg-Wither. Notes of a Journey from the River St. Francisco to the River Tocantins and to the City of Maranhao, by J. W. Wells. The Water-Shed of Central Asia, East and West, by T. E. Gordon. Notes accompanying a Chart of a Portion of the Niger Delta, by R. D. Boler and R. Knight. There are several papers, by C. M. Watson, W. Ellis, R. Strachan, and C. C. Gordon, on the White Nile.

The Report of Progress of the Geological Survey of Canada for 1875–1876 contains an interesting Report on Explorations in British Columbia, by George M. Dawson, comprising observations on the physical geography and surface geology of the Pacific coast north of Washington Territory.

MICROSCOPY.[1]

Schrauer's Microscopes. — L. Schrauer, who has removed his establishment to No. 50 Chatham Street, New York, has just issued a new catalogue in which his stands are described and figured. They adhere more or less to the Continental model, and aim at thorough excellence in working qualities, without great display. They are essentially laboratory instruments, and among the best of their kind. They are fur-

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

nished with Hartnack objectives. Besides the manufacture of stands, Mr. Schrauer gives special attention to repairing microscopes and other scientific instruments. He also makes the common accessories, including the binocular attachment.

KEITH'S HELIOSTAT. — A new heliostat, designed by Professor Keith, is now made by Edward Kubel, of 326 First Street, Washington, D. C. It is an excellent model, simplified without loss of efficiency, and no doubt the best instrument for the use of microscopists who require direct sunlight, for photography, blue-cell work, or any other purpose. It seems a full substitute for the expensive imported instruments. Its cost is $50.00.

PROCEEDINGS OF SOCIETIES.

AMERICAN JOURNAL OF SCIENCE AND ARTS. — November. Introduction and Succession of Vertebrate Life in America, by O. C. Marsh. Note on the Helderberg Formation of Bernardston, Massachusetts, and Vernon, Vermont, by J. D. Dana. Is the Existence of Growth-Rings in the early Exogenous Plants Proof of Alternating Seasons? by C. B. Warring. (The foreign journals were not received in time to be noticed.)

BOSTON SOCIETY OF NATURAL HISTORY. — October 17th. Mr. C. S. Minot made a communication on the Unity of all Forms of Muscular Contraction.

November 7th. Professor C. Semper addressed the members on a Land Mollusk from the Philippines; Onchidium, and its Dorsal Eyes.

NEW YORK ACADEMY OF SCIENCES. — November 5th. A paper was read by Mr. A. A. Julien, entitled Observations on the Geognosy of North Carolina.

AMERICAN GEOGRAPHICAL SOCIETY. — November 8th. Rev. Selah Merrill delivered a discourse upon Modern Researches in Palestine.

SCIENTIFIC NEWS.

IMPORTANT NOTICE TO SUBSCRIBERS. — The AMERICAN NATURALIST will hereafter be published by Messrs. McCalla & Stavely, Philadelphia, Pa., and will be edited by A. S. Packard, Jr., and Prof. E. D. Cope, with the assistance of eminent men of science. The January number, with an unusually attractive table of contents, will be sent out to past subscribers, and it is earnestly hoped that all will not only renew their subscriptions, but induce others to subscribe. A little effort on the part of the friends of science will now insure the prosperity of this useful and attractive journal.

ERRATA. — Page 72, for Glivieri *read* Olivieri. Page 122, for Peruvian *read* Permian. Page 603, fifth line from bottom, for *carpus* read *tarsus*.

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